Reduced Emission from Deforestation and Degradation in the Southern Cardamom Ecosystem, Cambodia

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Foreword

This study will provide a preliminary assessment for REDD carbon potential in the Southern Cardamoms Ecosystem, Southwest Cambodia. Complimenting the REDD activities, Wildlife Alliance is planning several reforestation projects throughout the region. A preliminary carbon assessment for the most advanced reforestation project can be found in Appendix IX.

Upon completion of this study we would like to thank all the staff at Wildlife Alliance, especially Sokun, Serey, Kethya, Michelle and Suwanna, for assisting us with finding information, the household survey and interviews. We would also like to thank the Forestry Administration for assisting us in the survey, Paul Gauger for help with GIS maps, and our six surveyors, Vathana, Phalla, Phou, Chey, Suwaranna and Samon, who helped us through three weeks of hard work. Finally, we thank Bart Nollen, ICE-BV, for having made it possible for us to do this interesting project in Cambodia.

Abstract

The aim of this study is to estimate the potential for generating carbon credits from Reducing Emissions from Deforestation and Degradation (REDD) in a region known as the Southern Cardamoms Ecosystem, Southwest Cambodia. Through the last decade, the Southern Cardamom Ecosystem has seen increasing pressures on the forest resources. The Royal government of Cambodia struggled to control degrading forest activities in the area alone and therefore sought the assistance of the NGO Wildlife Alliance in 2002. The option to attain carbon credits from REDD now offers an opportunity to achieve various goals: (1) to conserve the forest, (2) reduce CO_2 emissions, (3) support and develop local communities; and (4) generate revenues for the Cambodian government and the NGO Wildlife Alliance.

The potential amount of carbon benefits that can be generated has been estimated through an analysis of what is technical possible given the conditions of the project area, such as carbon density and deforestation rate. This technical assessment was complimented by an analysis of the current institutional and social conditions/barriers that can affect the actual quantity of marketable carbon.

It was found that the technical potential lies in the range between 0.4 and 1.3 million tCO_2/yr. However, the actual emission reductions that can be captured by REDD is dependent on how much deforestation can be reduced, and how effectively the project deals with the issues of permanence and leakage. These three aspects are in turn dependent of several institutional and social-economic factors. While the project is currently in the early phase of development, emphasis must be put on generating benefits for the local people who in reality bear the cost of reducing deforestation. Local people are a vital component to the overall success of the REDD project. Encouraging their participation and cooperation in the project can ensure long-term permanent emission reductions.

Abbreviations

AD	Avoided deforestation
AR	Afforestation/Reforestation
CADP	Community Agricultural Development Programme
CCBS	Carbon, Community and Biodiversity Standard
CDM	Clean Development Mechanism
CER	Certified Emission Reduction
COP	Conference of the Parties
CCX	Chicago Climate Exchange
FA	Forestry Administration
GHG	Greenhouse gas
IET	International Emission Trading
IPCC	Intergovernmental Panel on Climate Change
JI	Joint Implementation
LULUCF	Land Use, Land-use Change and Forestry
MAFF	Ministry of Agriculture, Fisheries and Forestry
MOE	Ministry of Environment
RED	Reduced Emission from Deforestation
REDD	Reduced Emissions from Deforestation and Degradation
RGC	Royal Government of Cambodia
SCE	Southern Cardamom Ecosystem
TWG-F&E	Technical Working Group on Forestry and Environment
UNFCCC	United Nations Framework Convention on Climate Change
VCS	Voluntary Carbon Standards
VER	Verified Emission Reduction
WTA	Willingness to Accept

1. Introduction

Tropical forests provide a range of valuable goods and ecosystem services, both locally and globally. At a local level, they provide resources for livelihood, regulate hydrological cycles and climate, and provide a rich habitat for an array of biodiversity. At a global level, they act as vast carbon sink, sequestering carbon dioxide (CO_2) from the atmosphere and locking it into stores of biomass.

Despite its ecological and economic importance, tropical forest is disappearing rapidly, causing a range of problems. Deforestation not only has severe consequences for local conditions but also as a primary source of greenhouse gas (GHG), makes a considerable contribution to global warming. It is estimated that tropical deforestation accounts for around 20 percent of the global CO_2 emissions (Chomitz 2006).

With large profits to be made from agriculture, plantations and economic development, there has been little to outweigh the opportunity costs of forest conservation in tropical countries. However, recent developments in the international carbon market offer an unprecedented opportunity to challenge the norm. The market mechanism that may provide opportunities is referred to as Reduced Emission from Deforestation (REDD).

The dominant global carbon market is regulated by the Kyoto Protocol under the United Nations Framework Convention on Climate Change (UNFCCC). This regulatory carbon market has so far, not committed to a mechanism for RED; however recent talks have lead to its likely inclusion in a post-Kyoto regime. For the moment, it is the voluntary carbon market that provides for REDD carbon trading. Many developing countries use the voluntary carbon market as a primer for establishing a national REDD accounting system post-Kyoto. This has lead to a plethora of project-based REDD activities budding throughout countries in the developing world.

Due to an earlier period of war and internal conflict, Cambodia is one of the few countries in Southeast Asia with a relatively high percent of its forest cover remaining. With this troublesome history, the country is emerging with a rapidly growing economy. While the Cambodian forests have been heavily exploited since the mid-nineties (Global Witness 1996, 2007), REDD now presents the country with a challenging choice: continued conversion and exploitation of natural resources or forest conservation. The early signals from government seem to point at the latter option. The year 2008 has seen the launch of the country's first REDD pilot project and the government is encouraging the development of more REDD projects.

One such REDD project in development is in the Southern Cardamoms, Southwest Cambodia. This ecosystem has been relatively isolated for many years, but like the rest of Cambodia, is experiencing increasing pressures from many fronts. Wildlife Alliance is a non-governmental organisation (NGO) working in the region in collaboration with government ministries. As part of an overall vision for the region these two organisations jointly created a master plan centred upon sustainable development and forest conservation. REDD financing plays a critical role in making this plan become a reality.

The aim of this study is to estimate the potential for REDD carbon benefits in the Southern Cardamom ecosystem. The potential amount of carbon benefits that can be generated is dependent on several overarching and overlapping factors.

In this study, three dimensions are of special interest: technical, institutional and socio-economic conditions.

The total physical volume of carbon benefits that can be generated by the REDD project is defined by the *technical potential*. This technical potential is limited by several institutional and social conditions that may reduce the actual marketable amount of carbon credits significantly below what is technical possible. The analysis will therefore commence with a technical assessment, which includes an estimation of total forest carbon stocks, a prediction of future deforestation within the project boundary, and a estimate of total carbon benefits by comparing "without" project to "with" project scenarios.

In the *institutional assessment* actors, policies and legalities which can potentially affect the REDD project, will be identified. The aim of this assessment is to get a better understanding of the potential institutional obstacles that need to be taken into account in developing a REDD project. Moreover, it helps to identify important actors and organisations that need to be involved in the design of the carbon activities.

The *socio-economic assessment* will identify social conditions, forest dependency and the effects on local livelihood of restricted forest use. Too often, exclusion of local communities from comparable projects has led to its failure. For the carbon project to be successful it is therefore important to address how the local people are affected, if they are in need of any type of compensation in return for the restricted forest use, and if it is possible to further increase restriction levels.

Before the main analysis, an introduction will be given to forestry and the global carbon markets, and to the Southern Cardamom Ecosystem and its drivers of deforestation.

2. Forestry and the global carbon markets

With a general consensus on global warming established, reducing global CO_2 emissions has been in focus of many decision makers around the world over the last decade. With these developments, many innovative ideas have been exchanged with the aim of reaching emission reductions by the most cost-effective means. With the arrival of an economic incentive to reduce CO_2 emissions, carbon has now become a marketable commodity. Seen as a cost-effective means of reducing emissions, investment is now pouring into forest[1] carbon mitigation projects.

Forests act as a natural carbon sink, removing CO_2 from the atmosphere through photosynthesis and capturing it in forest biomass, commonly known as carbon sequestration. Forest carbon is primarily stored in living biomass: stems, roots, leaves, etc., but there is also significant amounts of carbon stored in other carbon pools: dead wood, forest litter, and soil. There are a number of ways by which forests can mitigate CO_2 emissions: 1) Afforestation and Reforestation, where carbon is simply removed from the atmosphere as described above, and 2) Reduced Emissions from Deforestation[2] (RED).

Due to the extent of global forest cover and the devastating rate at which forests are destroyed, reducing emissions from deforestation[3] can have a significant and immediate impact on global CO_2 emissions. When forest is cleared or degraded, carbon stored in the sink is oxidised and released back to the atmosphere. It is estimated that approximately 20 percent of global emissions originate from this source (Chomitz *et al*. 2006). Therefore, reducing this source of emissions could potentially play a major role in future GHG mitigation.

As mentioned, the monetizing of carbon has lead to development of global carbon markets. REDD carbon is now emerging in these markets and may eventually account for a large share of globally traded carbon. The following sections will describe the basics of how marketable carbon is generated from REDD and discuss the current state concerning REDD and the global carbon markets.

2.1 Generating marketable carbon from REDD

To understand the global carbon markets, it is important to recognise the difference between the two trading systems: the cap-and-trade system, and the baseline-and-credit system. Both systems trade carbon in metric tonnes of CO_2, generically known as carbon credits[4].

Under a "cap-and-trade" system, an overall emission cap (or limit) is set to reduce emissions. Each participating member within the cap-and-trade system is then allocated a certain fraction of the total cap and is given an emission reduction target. The finite

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1 For a definition of what is defined as "forest" see Appendix I.

2 Lately forest degradation has been coupled with deforestation, giving rise to the term Reduced Emissions from Deforestation and Degradation, (REDD).

3 For an explanation of what is defined as "deforestation" see Appendix I.

4 Other GHGs can also be traded on the carbon market but are measured in relation to the global warming potential of CO_2 known as tonnes of CO_2 equivalents.

supply of allowances creates an overall deficit of emissions and this scarcity drives demand and market prices. The parties that have lower emission abatement costs will reduce their emissions internally and therefore have a surplus of allowances, while bodies that have higher abatement costs will need to buy allowances to emit more. Ultimately, the market reaches an optimum and the result is a cost-effective mitigation system.

The baseline-and-credit system does not involve a finite amount of allowances. Instead, carbon credits are created on a project-by-project basis by reducing emissions below a business-as-usual scenario, otherwise known as the baseline scenario. Carbon credits generated from this system can then be sold to offset emissions. Cap-and-trade systems often allow a small fraction of offsets to come from a baseline-and-credit system.

RED operates on a baseline-and-credit system. Carbon credits are generated from REDD activities by comparing emission levels that *would* occur in the *absence* of REDD intervention (i.e. the "without" project emission rate), with emissions levels under the "with REDD project" scenario. By implementing strategic activities aimed at reducing the core drivers of deforestation, the deforestation rate, and hence the emission rate, should inevitably fall. The potential quantity of carbon credits will depend on the difference between both of these emission trends. Figure 2.1 provides an illustration of the concept.

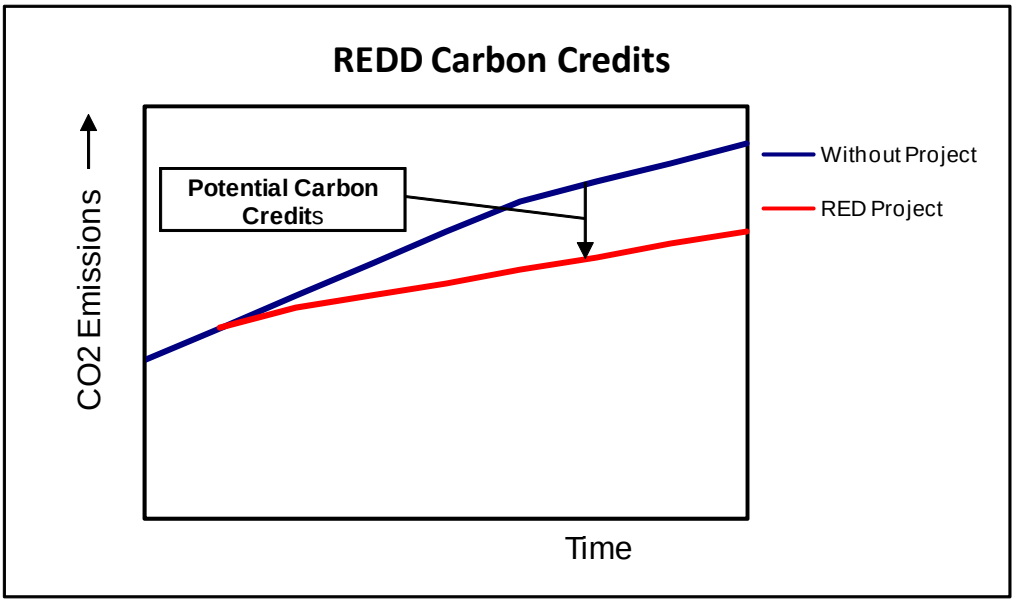

Figure 2.1 Baseline scenario of a REDD activity.

The potential carbon credits illustrated above represents the total amount of credits that can be gained from a REDD project activity. However, there are a number of issues that must be considered to ensure the quality of emission reductions from forestry carbon projects – three of these are most important to consider; *Additionality*, *Leakage* and *Permanence*.

Additionality addresses the question of whether the REDD project results in real CO_2 emission reductions, beyond what would have happened in the absence of project activities. In order for carbon credits to be certified to any of the recognised standards,

project proponents must first prove that emission reductions are indeed additional before the verification can proceed.

Leakage is often referred to as the "unanticipated loss of net carbon benefits of a project as a consequence of the implementation of project activities" (Brown *et al.* 1997b). While leakage is most often referred to as a negative externality, it may be sometimes possible that a conservation project can create a positive externality, referred to as "positive leakage" or "spillover" (Auckland *et al.* 2002). As the former has the potential to reduce carbon benefits this deserves more attention.

Auckland *et al.* (2002) identifies two types of Primary leakage[5] that causes negative externalities: "Activity Shifting" and "Outsourcing". Activity Shifting occurs when activities that were causing deforestation in the project area are simply displaced to somewhere outside the project boundary (e.g. shifting cultivators). Outsourcing is when commodities that were previously obtained through deforestation in the project area (e.g. charcoal) are purchased from deforestation activity originating from outside the project boundary.

Leakage is notoriously hard to avoid, but should be given apt attention as it will erode carbon benefits if not properly addressed. Leakage can be minimized through careful project design and providing alternative livelihoods or some form of compensation to the deforestation agents.

The term *Permanence* refers to the requirement that emission reductions generated through the REDD project activities last over time. Permanence of the carbon benefits is directly related to the amount of "risk" that can be attributed to the project as a whole. Project "risk" can be divided into two categories: 1) natural risk such as fire, climate change, disease, extreme weather events, and 2) human-induced risk such as forest encroachment, fire, uncertain land tenure and changes in price and opportunity cost of land (Orlando 2002). Most forms of natural risk are sporadic and difficult to predict or mitigate against. Human-induced risk, on the other hand, can be minimized through careful project design – addressing the drivers of deforestation and providing alternative livelihoods to the deforestation agents, the knock-on effect of which will also reduce leakage.

RED projects with a higher amount of permanence risk will generally produce fewer credits, and credits that demand a lower price (EcoSecurities 2007). Therefore it is necessary to invest in strategies that minimize risk early in the project design to maximize long-term benefits.

2.2 The compliance carbon market

The global Compliance Carbon Market is regulated by a binding international climate regime. The Kyoto Protocol provides the basis of the current regime. Founded in 1997 under the United Nations Framework Convention on Climate Change (UNFCCC), the Kyoto protocol has established a cap-and-trade system that imposes national caps on the GHG emissions of developed countries that have ratified the protocol (Annex B coun-

[5] For a thorough discussion on Primary *and* Secondary Leakage for avoided deforestation, please refer to Auckland *et al.* (2002).

tries). On average, the issued cap requires countries to reduce their emissions by 5.2% below 1990 levels in the first commitment period, 2008-2012 (UNFCCC 2008).

While reducing each country's own GHG emissions is the primary objective, the Kyoto protocol has also developed three specific emission reduction mechanisms to increase the cost-effectiveness of emission mitigation; International Emissions Trading (IET), Joint Implementation (JI), and the Clean Development Mechanism (CDM) (UNFCCC 2008). Of the three mechanisms, the CDM is most relevant for forest carbon projects. The CDM operates on a baseline-and-credit system. It allows Annex B countries to invest in carbon mitigation projects in developing countries to generate Certified Emission Reduction units (CERs). These CERs can in turn contribute to meeting the emission reduction commitments made by Annex B countries (UNFCCC 2008). Unfortunately, the possibility to generate CERs through REDD activities was excluded from CDM, at least for the first commitment period. This means that eligible forestry CDM projects are restricted to Afforestation and Reforestation (AR) activities only.

While many have expressed support for the development of REDD initiatives (Stiglitz 2005, Stern 2006) there were a number of reasons why efforts to include REDD in the CDM were defeated in the past. Many NGOs and environmental groups argued that polluting nations could simply "buy their way out" of making concerted efforts of permanent and substantial GHG emission reductions. Leakage and permanence issues were also of major concern. Furthermore, for many countries, national sovereignty was an issue. Some argued that by accepting payments from industrialized countries for reduced deforestation they could hinder their own future development (Chomitz 2006).

Although left out of the first commitment period, the debate over REDD was reignited in 2005. Since then, the concept has been gaining widespread political support that was emphasized at the Conference of the Parties (COP) -13 in Bali, 2007. While the Bali negotiations made advances regarding international REDD policy development, the outcome left many issues open for debate. Still, there was a clear commitment of parties to deal with REDD in the context of an overall package for a post-2012 regime. One major acknowledgment was for the inclusion of forest degradation in the REDD mechanism, giving rise to the term Reduced Emissions from Deforestation and Degradation (REDD). However, this evolved concept has raised further questions regarding definitional and methodological procedures. Nonetheless, by the end of 2009 (COP -15, December, in Copenhagen) all negotiations should culminate and lead to an agreement on the post-2012 regime. While future prospects for RED(D) look promising in the Compliance Carbon Market, carbon credits generated from such activities continue to be traded in the growing international Voluntary Carbon Market.

2.3 The voluntary carbon market

The Voluntary Carbon Market functions outside of international agreements and the compliance market. This parallel market enables individuals, companies, governments etc. without mandatory emission targets, to optionally offset some or all of their GHG emissions. In terms of forest carbon projects, the main difference between the voluntary and the compliance markets is that while both allow for AR, the voluntary market allows for additional forestry activities such as avoided deforestation, or REDD.

In general, the international voluntary markets can be divided into 2 distinct categories; the voluntary, but legally binding, cap-and-trade system of the Chicago Climate Exchange (CCX), and the disaggregated, non-binding, so called over-the-counter (OTC) offset market (Hamilton *et al.* 2008).

The CCX provides opportunities for generating carbon credits from avoided deforestation through "Combined Forestation and Forest Conservation Projects" (CCX 2006), meaning that both reforestation and avoided deforestation activities must be coupled together in a single project. However the amount of carbon offsets that can be issued from the "forest conservation" component cannot exceed the amount of offsets that can be generated by the "forestation component". This limitation significantly reduces the potential of the CCX market in relation to avoided deforestation.

Outside the CCX, there are a wide range of transactions that make up the OTC voluntary market. This market is not driven by the cap-and-trade system and is focused on project-based transactions. Contrary to the CCX, there is no limitation on avoided deforestation carbon offsets. Credits originating from the OTC market are generically referred to as Verified or Voluntary[6] Emission Reductions (VERs). Motives for purchasing VERs vary according to different buyers and include public relations, concern for climate change, preparation for (or deterring) upcoming regulations, or even to make profit by reselling credits (Hamilton *et al*. 2008).

Although there has been a steady growing demand for OTC credits, recently there has been concern about the quality of carbon credits produced, especially regarding the issue of additionality. While the CCX and the CDM provide their own rigorous standards and screening process, the OTC market has had no single universal standard to ensure VER quality. In response to the concerns raised, the past year or so has seen the rise of numerous third party standards, increasing the legitimacy and fungibility of VERs. There are two standards which have emerged as forerunners for REDD activities; the Voluntary Carbon Standard (VCS) and the Climate, Community and Biodiversity Standards (CCBS).

The voluntary carbon standard

The VCS is the first comprehensive carbon standard that covers all the major land-use activities.[7] Launched in 2007, the VCS is now the world's leading OTC market standard (Hamilton *et al*. 2008). Carbon credits that meet the VCS certification requirements are referred to a Voluntary Carbon Units (VCUs) as oppose to VERs. The standard aims to bring together best practices that already exist in the marketplace and has comprehensive measures to deal with additionality, leakage and permanence. The VCS also has a fully operational registry to register, transfer and retire VCUs from the marketplace. This registry allows for transparent trading of VCUs and ensures that double counting of credits is avoided. As part of the VCS criteria it requires each land-use project to "identify potential negative environmental and/or socio-economic impacts they might have, and effectively mitigate them prior to generating VCUs". However, the VCS does not monitor these impacts and project proponents simply must demonstrate that no negative

6 The term "Verified" or "Voluntary" is used loosely, depending on the source.

7 All land-use activities fall under the VCS category "Agriculture, Forestry and Other Land Uses".

environmental and social impacts will occur. Furthermore, the VCS does not require a local stakeholder approach beyond what is required by law and does not put emphasis on enhancing other co-benefits (Kolmuss *et al*. 2008), unlike the CCBS.

The climate, community and biodiversity standards

The CCBS is a set of project-design standards that focus exclusively on land-based carbon mitigation projects. The CCBS not only requires benefits to climate but also local community and biodiversity co-benefits. This standard is intended to be used early in the project-design phase to ensure that projects have the potential to deliver triple benefits. The standard sets out three levels of validation; approved, silver and gold standard, based on fulfilment of 23 criteria. To qualify as approved, the project must meet 15 mandatory criteria through independent third party validation. Depending on how many of the remaining criteria are fulfilled, the project can attain the silver or gold standard. The CCBS utilises existing methodologies of the Intergovernmental Panel on Climate Change (IPCC) Good Practice Guidance for GHG emission estimates. The standard screens for negative impacts on biodiversity and awards additional points for soil and water resource enhancement. The CCBS also stipulates a strong stakeholder involvement from the beginning of the project design and demands net benefits to the social and economic wellbeing of local communities. Furthermore, CCBS addresses the core issue of additionality, and uses an *ex-ante* approach to deal with leakage and permanence. As the standard focuses project-design, it does not provide its own carbon accounting system or registry. It is therefore recommended that the CCBS be combined with another carbon standard for certification and registration of credits such as the VCS.

Outlook for REDD and the carbon markets

From 2002 on, the voluntary market has seen a relatively healthy growth rate; however between 2006 and 2007 the market has expanded rapidly, with a 165 percent increase, and is set to further increase in the coming years (Carbon Trust 2006, Hamilton *et al.* 2007, Hamilton *et al.* 2008).

The total volume of credits traded on the voluntary market amounted to 65 million tCO_2e. Of this total, forestry and land based credits accounted for 18 percent with avoided deforestation credits accounting for 28 percent of this share, or 5 percent of the overall market share (growing from 3 percent the previous year). The average price for avoided deforestation credits in 2007 was estimated to be $4.80 (Hamilton *et al.* 2008).

Although the voluntary market is growing rapidly, it still remains a small fraction of the regulatory market (2.2 percent). Recent developments concerning the regulatory market however, have sparked major interest in REDD activities, with anticipating countries opting to pilot REDD projects in the voluntary market in preparation for its inclusion in a post-Kyoto regime.

3. REDD in the Southern Cardamom ecosystem

Located in Koh Kong province, Southwest Cambodia, the Southern Cardamom Ecosystem constitutes one of the last relatively intact ecosystems in Southeast Asia. Covering approximately 880,000 hectares the region is characterised by a varied topography (0-1000 m) and a moist tropical climate heavily influenced by the seasonal monsoon. Temperatures average 31.8˚C with an annual rainfall of 2,930 mm (FA 2007).

Approximately 720,000 hectares (80 percent) of the ecosystem is under forest cover, largely consisting of tropical evergreen forest with smaller pockets of semi-evergreen and deciduous forest. Much of the estuaries, deltas, and inland waterways are typically lined with dense thickets of mangrove slowly turning to stands of mellaluca moving inland. Moving from southeast to northwest, the Cardamom mountain range begins to climb. The hills formed one of the last strongholds for the Khmer Rouge and have therefore been inaccessible until only recently. This relatively remote landscape has provided refuge to a rich fauna and flora habitat, among others the endangered Asian elephant, the Indochinese tiger, the Malayan sun bear and the Siamese crocodile.

Administratively the Southern Cardamoms is divided between the Ministry of Agriculture, Forestry and Fisheries (MAFF) and its forestry branch, the Forestry Administration (FA), and the Ministry of Environment (MOE). The MOE are administrating the Botum Sakor region to the south that was classified as a national park in 1997 and has been protected by law since. The northern region falls under the jurisdiction of MAFF and FA. Much of this area was issued as logging concessions throughout the 1990s. However, in 2002, all logging concessions were suspended, and one third of the area was subsequently designated as a protected area.

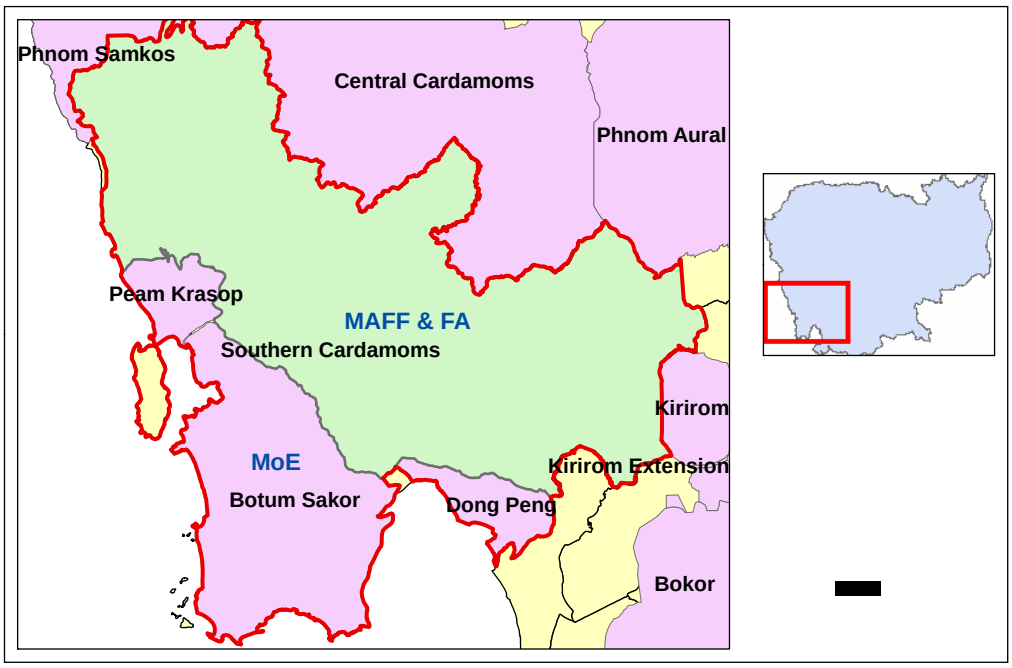

Figure 3.1 Map of the Southern Cardamom ecosystem.

Since 2002 the NGO Wildlife Alliance has put continued efforts and investment into protecting the Southern Cardamom ecosystem, cooperating with both the MOE and the MAFF/FA. The possibility to gain carbon credits from REDD offers potential to receive financial support so that forest protection and community development can be sustained and further enhanced. Securing carbon finance based on limiting deforestation will also offer an additional incentive for the Royal Government of Cambodia (RGC) to maintain the forest cover.

To further reduce deforestation, Wildlife Alliance has developed a Master Plan that focuses on increased protection, reforestation and community development. Implementing this plan can reduce deforestation and thereby be potential for a REDD project. Estimating the potential emission reductions in the area by implementing the Master Plan is the aim of this project. The potential emission reductions are a result of the difference in emissions between a "without" project scenario (no interventions) and a "with" project scenario (implementation of the Master Plan).

Due to several institutional barriers present in the MOE area, the area is currently not suitable for a REDD project. First, the cooperation between Wildlife Alliance and MOE has not been as successful as with the FA. MOE has been unwilling to integrate Wildlife Alliance officials in their patrolling teams, resulting in less organised and ineffective patrolling and law enforcement. Second, most of Wildlife Alliance's resources have been focussed in the MAFF area. This seems to have stabilised deforestation rates in the region. The MOE area on the other hand, deprived of resources and adequate levels of enforcement, has seen a sharp rise in deforestation rate. Further evidence of this will be given in the technical and socio-economic assessments. Third, although the MOE area is officially declared Protected, the region has been zoned for major development with over US$ 300 million to be invested over the coming years (Cambodian Embassy 2008). This far exceeds what can be generated through carbon revenues in the area. This project will therefore consider the MAFF area *only* for REDD carbon potential. However the MOE area will feature briefly in the technical assessment and again in the socio-economic assessment where respondents from both MAFF and MOE areas have been included. Differences between the two areas will be highlighted.

This chapter will commence with a short description of the historical drivers of deforestation, an overview of the work of Wildlife Alliance, and a description of the "without" project and the "with" project scenarios. The "without" and "with" project scenario forms the basis of the estimation of reduced carbon emissions in the technical assessment.

3.1 Historical deforestation and conservation

Historically, the Southern Cardamoms has been isolated and sparsely populated. In a rapidly developing country, this has changed in recent years. Deforestation within the ecosystem goes back to 1979, where political and social instability caused Khmer Rouge descendants to flee and hide in the forests of Koh Kong. From here, they began to establish an intensive timber industry, selling timber illegally to Thailand and overseas. Global Witness (1996) estimated that just between March and June 1995, over 33,000 m^3 of logs and 760 m^3 of sawn timber were exported from Koh Kong province to Thailand, generating approx. US$ 1.2 million for the Khmer Rouge. In the same period, local

people began to resettle in pristine forest areas. In the years that followed they would clear thousands of hectares of forest for agriculture and settlements (FA 2007).

In the mid 1990's the government introduced a new forest management system centred upon logging concessions. This period saw almost all forestland issued as logging concessions. This was followed by the inevitable construction of logging roads penetrating deep into forest that up until then had been relatively isolated (UN 2007). The logging roads opened new areas for settlement for the logging industries' labour force and an increasing population. This cauldron of events created a chaotic situation where anarchic logging and land encroachment spread fast along the new points of access. The 2002 logging moratorium provided some relief to the area; however the construction of road 48 connecting Phnom Penh to Thailand, cutting through the heart of the ecosystem, created a new threat.

The infrastructural development increased the regions accessibility and proximity to markets, making the area more attractive for economic and agricultural development. Slowly, the drivers of deforestation, once focussed on the exploitation of forest resources, shifted towards clearing forest for the sole purpose of capturing the land. The demand for land in the region has continued to increase, which in turn has driven spiralling prices, further encouraging land grabbers to clear forest, a common phenomenon found throughout Cambodia.

Despite this earlier chaotic situation, deforestation in the Southern Cardamoms is not completely out of control. In 2002, the high level of illegal forest activities coupled with lacking capacity within government institutions prompted the FA[8] to seek assistance from the NGO Wildlife Alliance[9]. Together the FA and Wildlife Alliance created the Southwest Elephant Corridor program (SWEC) aiming to protect the forest between Botum Sakor National Park and the Central Cardamoms Protected forest as a wildlife corridor. The program was based on three fundamental pillars: 1) ranger patrolling, 2) community outreach, and 3) wildlife monitoring (Wildlife Alliance 2003). Within four years Wildlife Alliance assisted FA in establishing five ranger stations across the SWEC area with a total of 70 rangers patrolling against forest crime.

In 2003 Wildlife Alliance and the Ministry of Environment (MOE) entered into agreement to create the Botum Sakor Conservation Project. The aim of the project was to assist the MOE in properly protecting the forest and wildlife in Botum Sakor National Park. Within a few months, Wildlife Alliance had trained and equipped 55 rangers for the area.

Besides assisting the FA and MOE in patrolling activities, Wildlife Alliance has also achieved several objectives contributing to the overall protection of the area. Some of these include:

- Reclassification of the 2 terminated logging concessions as Protected Forest
- Zoning of vast stretches of forest on either side of Road 48 for protection
- Demarcation of a number of forest/village boundaries
- Raising local community awareness through workshops and seminars

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8 Back then the Forestry Administration was known as the Department of Forestry and Wildlife.

9 See www.wildlifealliance.org for more information on the organisation.

- Establishing a Community Agricultural Development Programme (CADP) giving alternative livelihoods to farmers dependent on swidden agriculture and wildlife poaching.

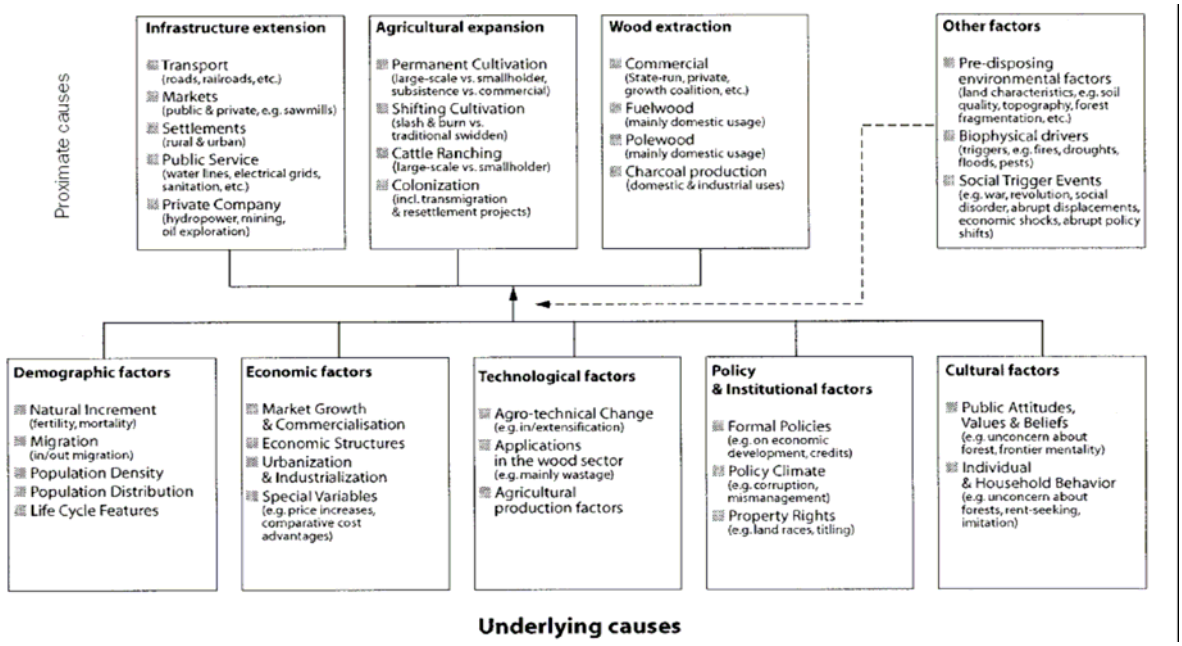
Currently, Wildlife Alliance is working to develop ecotourism in the region through Community Based Eco-Tourism (CBET). This programme also aims to provide alternative livelihoods for people dependent on forest resources. Another vital component of an integrated vision for the area is to estimate the ecosystems carbon potential for REDD.

3.2 Without project scenario

To predict the "without" project scenario, i.e. the carbon emissions without implementation of the Master Plan and finance from carbon credits, understanding the proximate and underlying drivers of deforestation is crucial. Identification of the drivers of deforestation is not only important for estimating the quantity of future deforestation, but also for designing effective measures to address deforestation (BioCarbon Fund 2008). However, future deforestation not only depends on deforestation drivers, but also on the level of protection and control that can be upheld.

The project area itself has until now, had a relatively low deforestation rate, but mounting pressures means that conditions are at a turning point and future deforestation rates are expected to increase.

Geist and Lambin (2002) analyse drivers of deforestation in tropical countries. They have developed a conceptual framework in which the drivers of deforestation are divided into proximate causes and underlying causes.



Source: Geist & Lambin (2002).

Figure 3.2 Proximate and underlying causes of tropical deforestation.

The drivers of deforestation in the project area will be analysed by adapting this framework. First, a short overview of the underlying causes of deforestation will be given,

where after they will be used to estimate the future importance of each of the proximate causes. The description of proximate drivers of deforestation is structured according to classification of Geist and Lambin (2002); 1) *Infrastructure Extension*, 2) *Agricultural Expansion* and, 3) *Wood Extraction*.

Underlying drivers

The setting for the underlying drivers of deforestation is in a country experiencing rapid economic growth. Within the past decade, and especially the last four years, economic growth has been around 10 percent annually (UN 2008). Inflation has recently hit the country, with the latest available figure being 18 percent in January 2008 (Phnom Penh Post 2008). This inflation, coupled with the current unstable rice market, has been the primary contributor to the 24.2 percent increase in food price, between January 2007 and January 2008 (NGO forum on Cambodia 2008).

Economic growth and an increasing influx of foreign capital have also driven an enormous rise in land prices. The exploding land prices first took place in the capital and main tourist centres, but have now spread across the country, with areas along the borders of the country being noted hot spots. Koh Kong province has a number of features, which make it especially attractive for development and subsequently one of these hotspots: a close proximity to Thailand, a large coastal area, and a newly constructed highway connecting Phnom Penh with Bangkok. Land prices in Koh Kong have correspondingly increased, giving an average growth rate of 14.4 percent a year since 1995, with the current price of agricultural land approx. 4000 US$ per hectare (Ministry of Commerce 2002, Angkor Real Estate 2008). This price increase, together with the government's plans to further develop the area around Koh Kong town to a Special Economic Zone (SEZ), has sparked widespread land speculation in the region, with people encroaching on the land to claim ownership, for thereafter to sell it (Cambodia Mirror 2008).

Agricultural development will also be in focus over the coming decades. Agricultural improvement and growth is taking high priority with the RGC and is seen as a critical factor for enhancing rural and economic development (MAFF 2006). In general, the agriculture in Cambodia has seen some major improvements over the last couple of years, including the use of *High Yielding Varieties* (HYV) and agrochemicals (Mund & Ngo 2005). The government is focusing on production efficiency, giving rise to the dominance of large-scale economic land concessions. It is therefore expected that these concessions will continue to be promoted, most likely displacing local small-scale agriculture due to insecure land tenure.

Besides economic and agricultural development, population growth is expected to have a significant influence on the Southern Cardamoms. Koh Kong has been identified as the province with the highest expected population growth in all of Cambodia, with an average annual growth rate between 2001 and 2021 of 4 percent (National Institute of Statistics 2000).

This large population growth, together with high inflation, promotion of economic land concessions, insecure property rights and a system where economic development mostly benefits the wealthy can create a situation where local resource dependent communities are at high risk from being further alienated from the developing society. Together, these

mounting pressures will result in an increasing demand on local ecosystem services and give bleak outlook for sustaining existing forest cover and quality.

Infrastructure extension

Infrastructural extension will transform large areas into roads, settlements, industry and hydropower. The recent completion of the National highway 48 has increased land encroachment a) directly, by increasing accessibility to the ecosystem, and b) indirectly, by increasing the value of the accessed land. Several new roads are likely to be constructed and improved which will further open up the area to encroachers as well as illegal wildlife traders. The area has already attracted several land speculators and businessmen who are paying locals to clear land, and then attempting to claim ownership. Besides enhancement of the road network, the two main infrastructural extensions will be settlements and hydropower.

Settlements

Until recently, the Southern Cardamoms has seen relatively low pressures due to remoteness, but is now experiencing increasing pressures from development. As mentioned, its proximity to Thailand and the recently completed National highway 48 is spurring investors' interests and several plans are in development. The former Thai Prime Minister, Mr. Thaksin, has repeatedly expressed that he wishes to make sizeable investments in Koh Kong province so it can become the "second Hong Kong" (KH 2008). The development plans include the construction of a new financial centre, residential areas, hospitals and infrastructure. In Botum Sakor, a Chinese company, Tianjin Union Investment Development Group, will be investing more than 300 million US$ in developing the western side of the Botum Sakor peninsula as a tourist destination, containing trade centres, golf courses and hotels. The plan has already been approved by the Cambodian Development Council (CDC), and will affect large parts of the protected area (Embassy of Cambodia 2008). Additionally, the projected high population growth, coupled with in-migration stimulated by greater livelihood opportunities, will result in an expansion of local settlements. These settlements are likely to take up significant areas of land, and demand large pools of resources to fuel growth and their existence, therefore either directly or indirectly increasing the pressure on the forest.

Hydropower

The growing economy of Cambodia is seeing an ever-increasing demand for electricity. Taking into account that only around 20 percent of the population currently have access to electricity, and that availability and security of electricity is important for a continuous economic growth, electricity generation is a high priority of the Cambodian government. With a relatively flat landscape, hydropower is viable only in the mountainous areas to the northeast and southwest, much of which is protected area and where indigenous people, dependent on the natural resources reside. For these reasons, many donors have denied supporting the construction of hydro dams in Cambodia. However, this has not stemmed strong support from China, and the Cambodian government now has extensive plans for hydropower development. Even though the hydropower plants will have severe environmental and social consequences, many of the projects are likely to go forward, due to the high level of governmental support. The government's little concern of

environmental and social impacts can already be seen at this early stage in hydropower development. The first large-scale domestic hydropower project currently under construction, Kamchay Dam, is located within a protected national park and will flood 2000 ha of forest having a huge affect on local communities dependent on NTFPs (Middleton 2008).

Of a total of 50 potential hydropower sites in the country, 13 sites have been identified in the project area (see Figure 3.3), one of which has already been approved. A further 6 sites have been identified as priority projects by the Ministry of Industry, Mines and Energy in 2003 (Middleton 2008). Without heavy incentives to protect the forest it is likely that these six projects will be realised within the next 10 years. Limited information is available on the exact dimensions and impacts of the proposed hydropower plants, but thousands of hectares of forested land and several villages are destined to be inundated. If people lose their land to development, or if crop yields decline due to change in water quantity or quality, the affected people will inevitably have to settle somewhere else. Due to the fact that the proposed dam locations are in remote areas, well inside the forest boundaries, these displaced communities may have no choice but to clear forest to survive. Of the six hydro dams planned for the region, there are inundation figures available for two. These figures estimate that up to 3,000 hectares of forest and indigenous land will be flooded following dam construction, with serious concerns for some 2,100 downstream rice paddy fields dependent on upstream run-off (Middleton 2008). This gives some idea of the magnitude of potential impact if all six, or maybe even 13, dams are developed.

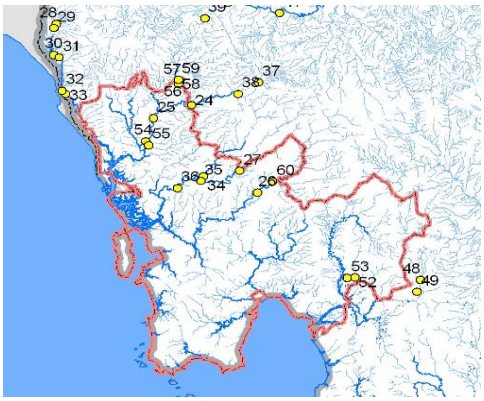


Figure 3.3 The 13 potential hydropower sites in the Southern Cardamoms.

The impacts of a hydro plant on the carbon stocks are severe. When vegetation is inundated, a process of rotting will begin and heavily polluting compounds will be emitted to the water and high impact GHGs such as methane will be emitted to the atmosphere. Therefore, it is recognised that all vegetation should be cleared prior to inundation to minimise the environmental impact (Middleton 2008). So, even though hydro power is considered a "clean" source of energy, as a replacing land use, it will have zero carbon stock, and may even be a source of GHG emissions.

Agricultural expansion

The strong emphasis on agriculture as a driver for economic development will have a considerable influence on the transformation of the landscape within the next decade.

Cambodia's membership of the WTO, as well as higher food prices and inflation, will drive an expansion of agricultural-based industries into forested areas, or will indirectly affect deforestation by displacing local communities from their agricultural land. High population growth projected for the region, coupled with growing food prices is also likely to increase small-scale-agriculture.

Economic land concessions

Although soil fertility in Koh Kong province is relatively low, accessibility to major markets in Phnom Penh and Thailand via road 48 is likely to further increase interest from large agricultural companies. Since 2002, Wildlife Alliance has been working intensively to reduce the impact that economic land concessions have on the region. So far, they have convinced the government to reduce Green Rich pulp and paper concession by some 52,000 hectares, as well as influenced the cancellation of several planned concessions. With increasing pressures from the agricultural industries, widespread disregard for laws and regulations, and no governmental revenues from carbon credits, more economic land concessions are likely to be issued in the area. The concessions could affect forest cover in two ways: a) forest will be simply cleared for the concessions, or b) the concession is given on land that is used by local people, who in turn have to find a new piece of land. In contrast to logging concessions, economic land concessions are given primarily for the use of the land, and not necessarily for the trees the forests contain. Therefore, companies are incentivised to clear forest in a short period of time, making the impacts on the environment even more severe.

Small-scale agriculture

Local people in the region have been clearing land for agriculture for generations. Through various community projects and enforcement of the law, Wildlife Alliance has partially reduced the magnitude of agricultural clearing. However, with increasing pressures set to mount over the coming years and with an exploding population growth, small-scale agriculture has potential to accelerate in the future. It was found through the household survey that respondents perceive small-scale agricultural expansion as the main driver of deforestation (see socio-economic assessment, chapter 6). It was also found that the poorest, resource dependent population have to clear land for subsistence. If comprehensive measures are not taken to assist local communities in an intensification of agriculture as well as becoming less dependent on natural resources, these practices will continue to impact on forest cover.

Wood extraction

Historically, wood extraction has been one of the major drivers of deforestation, but today is surpassed by the demand for land. Forested areas are being bulldozed, and the once valuable forest resources, are left to burn. However, there are several factors that can make wood extraction increase deforestation in the future.

Logging concessions

The logging concessions that have been under moratorium for the last five years could possibly be re-opened in the future. Of the five forest concessions in the project area, two have been cancelled, and the remaining three are currently being reviewed. Without an

economic incentive to protect the forest, these three concessions covering two thirds of the project area may be re-established. It is, however, more likely that agricultural concessions will be prevailing, but some of the more remote and elevated areas not suitable for agriculture, and still possessing valuable timber, could easily be re-issued as logging concessions.

Local timber demand, firewood and charcoal

With increasing population and development, the demand of timber, firewood and charcoal will inevitably increase. Timber is the primary construction material for almost all dwellings in the area. Timber is also used for making boats, fences, tools, etc. Although it is prohibited to fell trees without permission, an increase in demand coupled with insufficient patrolling, could see a return of illegal logging in the area.

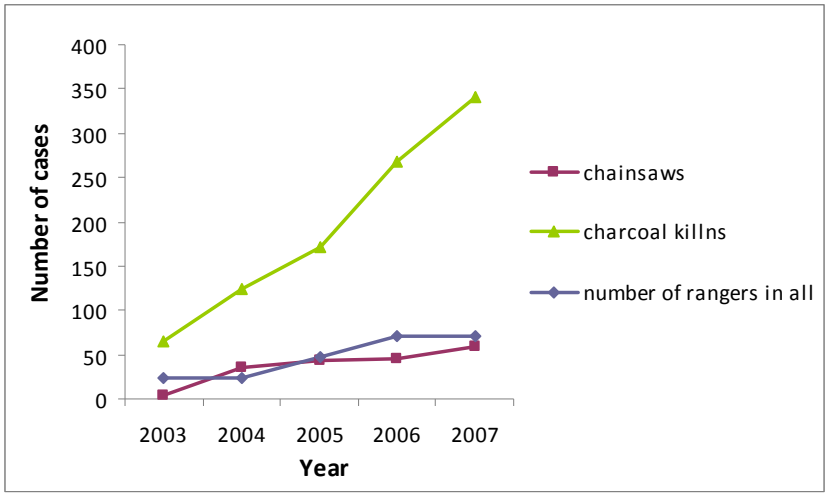
The cooking fuels of firewood and charcoal are a necessity for almost all people living in rural Cambodia, and with a growing population the impacts on the forest can be severe. Around 84 percent of the Cambodian population is dependent on firewood for cooking. Firewood is normally collected from dead wood, and therefore does not damage the forest when collected on a small scale. However, firewood was in the household survey found to one of the main drivers of deforestation by respondents, and with a rising demand, the impacts could easily increase impact on forest cover and quality (see socio-economic assessment, Chapter 6).

Although firewood is the most important source of energy for locals, charcoal production represents a significant threat to forest cover, especially because it is produced at a commercial level, uses live wood as a raw material, and is produced highly inefficient.

A simple calculation can show how much an increase in population can affect demand for live wood in the form of charcoal. The FA management plan (2007) mentions that an average household of 7 persons use 52 kg of charcoal per month. With a population increase of approx. 10,340 persons a year in Koh Kong province from 2006 to 2021 (National Institute of Statistics 2000), the demand for charcoal alone will grow by 920 tons a year. With a yield of a traditional charcoal kiln of 15 percent (Geres 2008), this equals 10,200 m^3 of hard wood, or 50 hectares of forest a year[10]. This means that in ten years, the additional demand could reach over 500 hectares of forest each year. The demand for charcoal in the project area is already on the rise. Figure 3.4 shows the number of charcoal kilns and chainsaws that Wildlife Alliance has found in the project area during the last five years.

Even at the current protection level, the number of illegal charcoal kilns is increasing sharply compared to that of chainsaws. It has to be taken into account that Wildlife Alliance has increased the number of rangers and stations through the years; however, the increase in charcoal kilns is of considerable concern. If control is not increased together with introduction of alternative energy sources or improved charcoal kiln and stove efficiency, charcoal production will represent a very significant threat.

[10] Calculated on the basis of: Density of hard wood: 600 kg/m^3 (Geres, 2006), Average Forest stocks per hectares: 200 m^3/ha (FA, 2007).



Source: Wildlife Alliance annual reports 2003-2007.

Figure 3.4 Frequency of found charcoal kilns and number of chainsaws in the project area.

3.3 With project scenario

In the "with" project scenario, Wildlife Alliance will implement several project activities as described in their *Southern Cardamom Conservation for Development program – Master Plan* (Wildlife Alliance 2008) that will contribute to environmental, as well as social and institutional improvements.

The overall goal of the Master Plan is to implement sustainable development in the Southern Cardamom Ecosystem, enhancing economic growth in the region, while protecting valuable natural resources and improving the livelihood of local communities. The Master Plan is focussing on four main pillars to achieve the goal; 1) agricultural support and development, 2) eco-tourism, 3) institutional development and 4) forest protection including several reforestation projects.

The project will aim to protect the forest within the project boundary as well as forested land to the south, in the Botum Sakor National Park. Project activities will result in the creation of over 2,826 jobs for local people, as well as increased institutional capacity in the Cambodian government for long-term management of the area.

Components of the agricultural plan

The agricultural plan will focus on continued development of the CADP, as well as support for sustainable agriculture in three communes, Chi Phat among one of them. All three communes in focus are situated in the upland, where soil is poor, rice yields low and opportunities for alternative livelihoods are relatively low. The program will focus on families dependent on slash and burn cultivation who will be assisted with agricultural know-how, together with modern agricultural equipment.

Eco-tourism development

There are extensive plans to develop sustainable eco-tourism in the region, including eco-lodges, visitor centres, infrastructure and several others measures. The planned eco-

tourism development provides training of locals so they are capable of delivering necessary services, such as labour, guided tours for the tourists, etc. This will create several direct as well as indirect income opportunities for local people. The overarching aim is that with increased forest protection levels, as well as wildlife rehabilitation, the area can become the jungle-experience in Cambodia, and a second tourist hot spot after Siem Riep (Angkor Wat).

Improving institutional capacity

Institutional capacity will be improved by assisting MAFF and MOE in developing guidelines for how to manage the protected areas, as well as reviewing their current activities so more clearly defined management roles and responsibilities can be developed. A park management advisory council would also be created, consisting of local government members, non-governmental stakeholders, and Wildlife Alliance, aiming to advice MAFF and MOE on management strategies as well as solving conflicts in the Southern Cardamom Ecosystem. Finally, the Master Plan includes training and education of staff from governmental institutions and continued training of rangers.

Forest protection

The forest protection component includes construction of five new ranger stations in the MAFF area and one new station in the MOE area. There are also areas zoned for wildlife rehabilitation, research centres, and reforestation and forest rehabilitation. The forest protection plan will increase forest cover, enhance protection levels, and make forest areas available for communities. There are currently 12 sites proposed Community Forestry in the Master Plan. Furthermore, approximately 2,700 hectares of land around Chi Phat will be replanted with natural forest. This reforestation activity offers additional potential for generating carbon credits and will therefore be included as a component of the carbon credit potential in the “with” project scenario. There are further plans for future forest rehabilitation and reforestation for a larger area of approximately 9,000, however this will not be included in the carbon assessment.

4. Technical assessment

The primary focus of the technical assessment is to estimate the quantity of carbon credits that could be generated by implementing a REDD project in the Southern Cardamoms. This will be done by comparing expected emissions in the "without" project scenario with expected emissions in the "with" project scenario. The difference in emissions between the two scenarios will represent the total technical potential. Figure 4.1 illustrates the methodology used.

Since it is the forest ecosystem that contains the carbon of concern, the first step is to establish the current extent of forest cover. The forest cover must then be stratified into different categories that will be expected to have varying carbon densities.

The second step is to quantify how much carbon will be contained within each of these categories. The combination of these two steps will give a picture of the total carbon stock for the entire ecosystem and give an estimate of the average carbon density per hectare of forest.

The third step is to quantify how much of this forest will be lost in the future "without" project scenario. Since there are uncertainties about future deforestation in the region, a deforestation range will be presented using two alternative approaches.

The final step will be to estimate total carbon potential by comparing the "without" and the "with" project carbon emissions to give the total carbon potential. This comparison will depend on the carbon emissions from deforestation and the carbon densities of the replacing land uses in both scenarios.

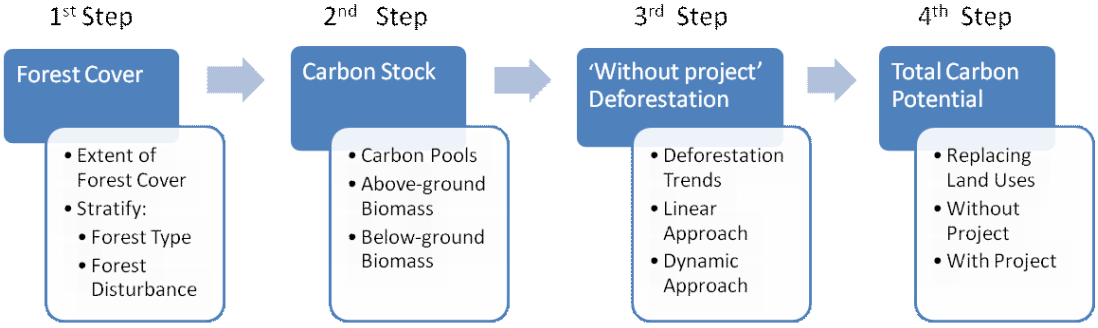
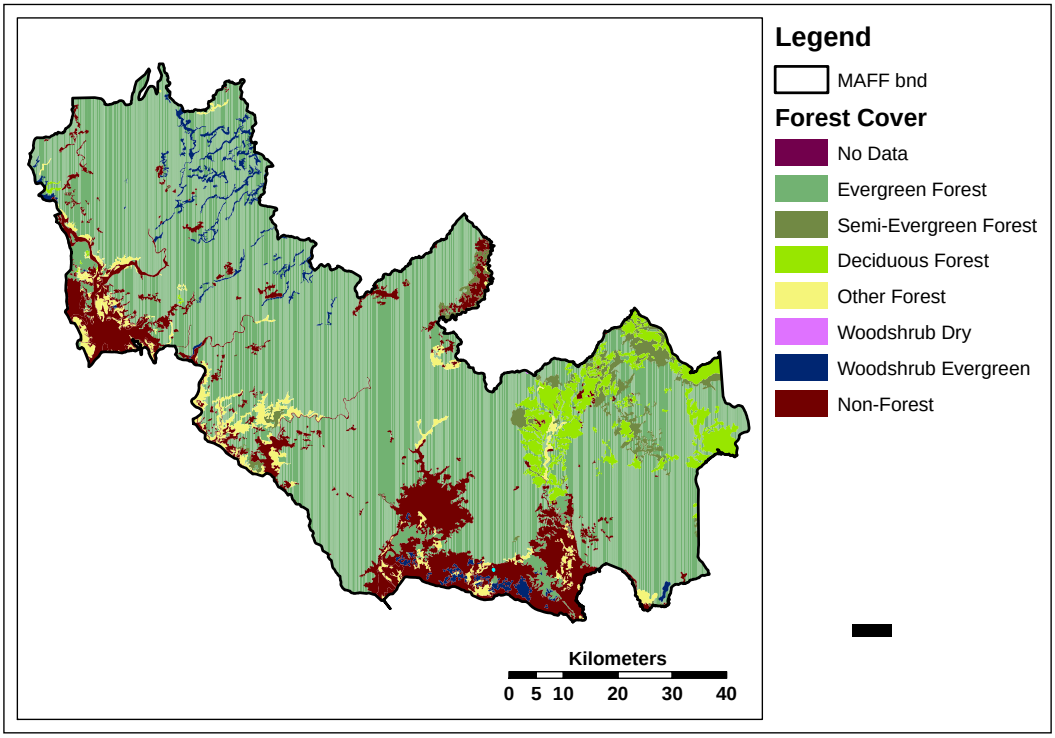


Figure 4.1 Flow diagram of the methodology for the technical assessment.

4.1 Forest cover

Carbon stocks contained within tropical forests are highly varied and unevenly distributed. Some forest types such as evergreen forest have a high carbon density, while others may have lower. Carbon stocks not only vary between forest types, but also within, depending on factors such as geology, soil type, slope, altitude, local climate and land use history.

The southern Cardamoms is considered a tropical forest ecosystem and supports a diversity of tree species and vegetation, largely contained within four distinct forest classifications; evergreen, semi-evergreen, deciduous and other forest (Figure 4.1).



Source: The FA's data was used from the Cambodian forest cover assessment for 2005/2006 (FA 2008a) and adapted in ArcGIS. Maps were based on LandSat imagery 30x30 m resolution.

Figure 4.2 Forest cover of the project area in 2005/2006.

The project area is dominated by large expanses of evergreen forest, making up almost 88% of the total forest cover. There are smaller pockets of semi-evergreen (3.1%) and deciduous (5.4%) forest contained mainly within the valleys to the north and northeast. The classification "other forest" includes forest re-growth, stunted forest, inundated forest, mangrove, forest plantations and bamboo. This varying forest classification is predominantly found close to rivers, roads and villages, in areas of poor soil and drainage, and covers 3.8% of the total forested area (see the forest areas in Appendix II)

4.1.1 Forest disturbance

To increase the accuracy of the carbon stock estimate it is important to stratify the forest as much as possible into different categories, each representing a unique average carbon density. The forest cover has already been divided into 4 broad forest types, evergreen, semi-evergreen, deciduous and other forest. It also makes sense to further divide forest cover into intact and disturbed forest, as intact forest will hold more carbon than disturbed or degraded forest. By applying a lower carbon density value to the disturbed forest this will also contribute to more conservative carbon estimation.

Historically, different compartments of the project area have been through the hands of numerous commercial logging companies (see Chapter 3). These companies created a vast network of roads and tracks used to penetrate the forest and transport the timber to saw mills and the marketplace. Forest with close proximity to roads, therefore, can be considered disturbed, to some extent, by the selective logging practices of the logging

companies. Once these logging companies have moved on, the roads provide open access to more illegal loggers, land grabbers, chamka, and settlers to move in, further degrading the forest.

The proximity to villages will also have an effect on the condition of the forest. The connection between forest degradation and village location is well established (Chomitz 2006). Often the logging companies employed people from the villages, and so the village became a hub for logging activity. Villages also need a constant supply of firewood and timber for construction, further adding to the pressure on the surrounding forest. The village of Chi Phat serves as a good example of forest degradation on the village periphery.

Forest disturbance model

In general, carbon densities in tropical Asia decline by 22-67% after logging disturbance (Lasco 2001). Although figures for disturbance have a wide variance we choose a figure close to that reported by Hairiah and Sitompol (2000). This study reported almost 40 percent decline in carbon stock after logging in Bogor, Indonesia. This value was chosen to represent *disturbed* forest, and reduced by half to represent *less disturbed* forest. To distinguish between *disturbed, less disturbed* and *intact* forest a simple GIS model was made using a similar approach to the forest disturbance model created by the IFSR (2004). The model used for this study is based on the following assumptions:

a. *Disturbed* forest holds 60% of the aboveground biomass of *intact* forest.

b. *Less disturbed* forest holds 80% of the aboveground biomass of *intact* forest.

c. A 1.5 km buffer was created around each *main road* within the project area. This buffer was divided into 2 zones. The inner 1 km zone of the buffer is considered *disturbed* forest. The remaining outer 500m of the buffer are considered *less disturbed*.

d. A 1 km buffer was created around each *minor road* and *track* within the project area. This buffer was divided into 2 zones. The inner 500m zone was considered *disturbed* forest. The remaining outer 500m zone was considered *less disturbed* forest.

e. A 5 km buffer was made around each village location. This buffer was again divided into 2 zones. The inner 2.5 km of the buffer is considered *disturbed*. The remaining 2.5 km of the buffer is considered *less disturbed*.

f. Forest zoned as degraded by wildlife alliance was overlaid and included in the *disturbed* buffer zone.

g. Forest cover that remains outside the buffer zones is considered *intact* forest.

Figure 4.3 provides an illustration of the GIS model. The results are summarized in table 2, Appendix II.

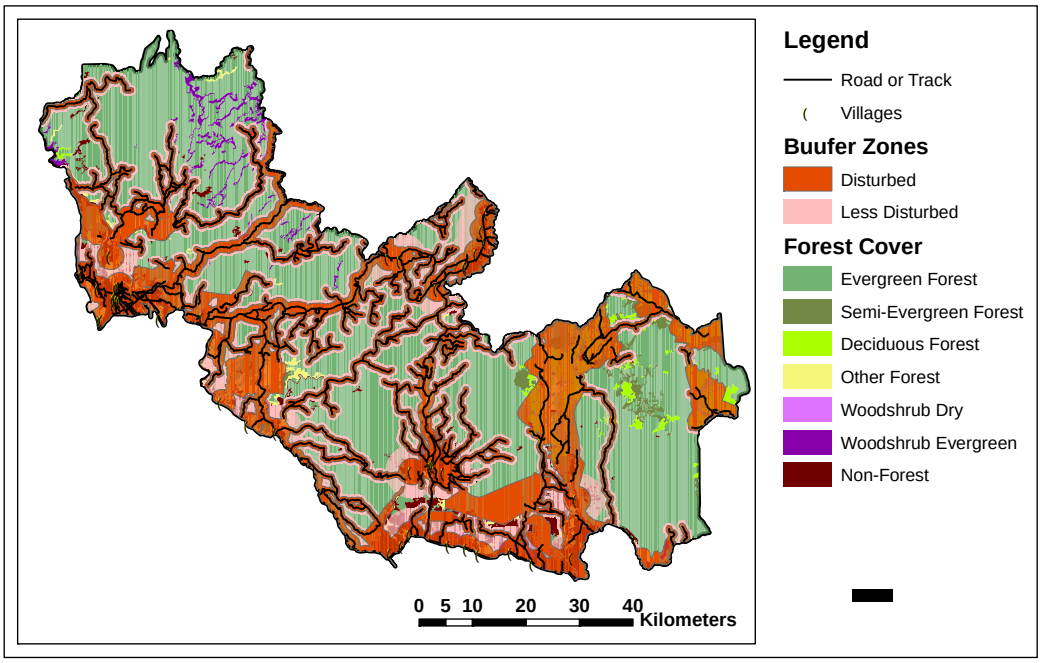


Figure 4.3 Forest disturbance model. The map was created using data layers from Wildlife Alliance.

4.2 Carbon stock

When measuring the total carbon stocks for avoided deforestation there are five carbon pools eligible for consideration:

1. Aboveground Biomass (Tree and Non-tree)
2. Belowground Biomass
3. Litter
4. Dead wood (lying and standing)
5. Soil organic carbon

Of the five carbon pools, aboveground biomass typically stores the largest amount of carbon and is most directly affected by the destructive activities of deforestation and forest degradation. Therefore, estimating aboveground biomass plays a critical role when quantifying forest carbon stocks and fluxes. Proponents of a REDD project are free to include any of carbon pools in the calculations, with aboveground biomass specified as being the only mandatory category. The belowground biomass pool usually represents a significant fraction of the total carbon stocks and is therefore “recommended” to be accounted for (VCS 2007, BioCarbon Fund 2008).

By excluding the remaining carbon pools from the calculations this will ensure that carbon benefits generated by the project will not be over-estimated. This is consistent with current REDD and carbon accounting methodologies of conservative estimation (IPCC 2006, VCS 2007, CCBA 2005, BioCarbon Fund 2008). For this reason the following section will provide an estimate of above- and belowground biomass for the project area. This will be the first step in estimating the potential magnitude of carbon credits that can be generated.

As for the remaining carbon pools, if found to make a significant contribution to the total carbon stock, they can be estimated at a later date. An estimate of these can be made by referring to widely excepted lookup tables and using established correlations to above-ground biomass. For example, the litter or dead wood carbon stocks are typically assumed to be approx. 10-20% of aboveground forest biomass for mature forests (Harmon and Sexton 1996, Delaney *et al* 1998).

Aboveground biomass

The aboveground biomass of forest system can be estimated using a number of techniques with varying levels of detail and accuracy. The IPCC describes these levels as different "tiers" ranging from tier 1 (lowest level of confidence) to tier 3 (highest level of confidence). Tier 1 level assessments use IPCC default values for carbon pools in different forest biomes (i.e. *biome-average approach*); Tier 2 focuses on using country specific data (i.e. from filed inventories); while Tier 3 requires highly disaggregated and detailed inventory data of carbon stocks and relative change (i.e. Project specific carbon inventories). Progressing from Tier 1 to Tier 3 will increase the precision and accuracy of the output, however this will in turn increase the complexity and costs of the carbon estimates and monitoring programme (Achard 2008).

Gibbs *et al* (2007) provides a comprehensive overview of the available carbon estimation options, their advantages and limitations:

1. The *biome-average approach* uses a single representative value of forest carbon and applies this across broad categories of global forest types or biomes. This approach yields a high level of uncertainty and is therefore considered a "Tier 1" (IPCC 2006). Despite obvious limitations, biome-averages provide the only globally consistent dataset on forest carbon stocks; they are readily available, and easily applied. For these reasons, they continue to be the most routinely used source for forest carbon accounting.
2. *Forest inventories* use ground based tree measurements within randomly selected sample plots of "diameter at breast height" (DBH), or tree volume. These measurements can then be converted to carbon stocks using allometric relationships. Although time consuming, and labour intensive, this method provides a low-tech assessment that yields most reliable and accurate results (Tier2/Tier3).
3. Recent developments in radar, laser and high-resolution *remote sensing* technologies, in combination with ground data collection, have the potential to produce reliable carbon estimations. Unfortunately, using these methods can be very expensive and technically demanding (Tier 3).

The aboveground biomass for the project area can be estimated by starting with a detailed review of the current literature. Table 4.1 provides a summary of the relevant findings. Upon review, there are a) 4 *biome-average*, and b) 3 *country specific* above-ground biomass estimations to be considered. After an analysis of each data set in Table 4.1, a decision can be made about which data set best suits the project area.

Table 4.1 A summary of above ground biomass estimates that could be applied to the project area.

Source	Region	Forest type	AGB (t/ha)	Total C (tC/ha) a	AGB tC/hab	AGB (CO_2/ha)c
Biome-average						
IPCC (2006)	Tropics	Tropical	280		132	483
Achard (2004)	Asia	All		151	126	461
Houghton (1999)	Asia	Tropical moist		250	208	764
Brown and Gibbs (2007)	Asia	Tropical equatorial		164	137	501
Country specific						
Brown (1997a)	Cambodia	All Cambodian	301		151	552
Sasaki 2006	Cambodia	Production			131 > 115d	
		Protected			161	
		Inundated			88	
Top *et al*. 2006	Cambodia	Evergreen	291		146	534
		Semi-evergreen	265		133	486
		Deciduous	235		118	431
		Re-growth	39		20	72

[a] Total Carbon; In this column figures include both above- *and* belowground biomass stock in tonnes of *carbon* per hectare (tC/ha) as opposed to the previous column showing aboveground biomass only in tonnes of *biomass* per hectare (t/ha).

[b] Tonnes of Biomass per hectare (t/ha) is converted to tonnes of Carbon per hectare (tC/ha) by multiplying by a factor of 50%. The only exception is IPCC, which use a specific biomass to Carbon conversion factor of 47% for tropical forests.

[c] Aboveground biomass (AGB) tC/ha was converted to (AGB) CO_2/ha by multiplying by the C to CO_2 factor of 3.667.

[d] The model created by Sasaki reduced the initial 1993 estimate for carbon stocks in Production forest (131 tC/ha) to a 2003 estimate (115 tC/ha) based on the models assumptions.

Biome-average estimates

Four sources of biome-averages estimates were identified:

1. *IPCC (2006)* estimates are the most widely used values for national carbon inventories and considered best practice when limited information is available. These values are based on interpretation of compilations of published studies, mainly done by Penman *et al* (2003). Referring to observed climate and vegetation patterns by FAO (2001), the IPCC classifies forest in the project area as being within the ecological zone "Tropical rain forest" (IPCC (2006) Chapter 4, Table 4.1). The project

area can be further distinguished as being from "Asia (continental)" with a corresponding aboveground biomass value of 280 t/ha (IPCC (2006) Chapter 4, Table 4.7). The above ground biomass value can be converted to carbon stock using the IPCC default carbon fraction for tropical forests of 0.47 (IPCC (2006) Chapter 4, Table 4.3) giving an aboveground biomass carbon stock of 132 tC/ha.

2. *Archard (2004)* derived his calculation of carbon biomass (tC/ha) based on national figures of total carbon vegetation without roots, published by Brown (1997a). In order to obtain the regional estimate for total carbon biomass of all forests of Asia, Achard weighted each country's biomass figures with forest area country figures from FAO. Since Browns estimates only include aboveground biomass, Achard added 20% for belowground root biomass to give an estimate of 151 tC/ha for all tropical Asian forests. Subsequently, this 20% root: shoot ratio is subtracted from his figure in Table 4.1 to give an aboveground biomass carbon stock of 126 tC/ha.
3. *Houghton (1999)* obtained his carbon biomass estimate for Asian tropical moist forests from summaries of global vegetation as well as from other regional studies. This estimate of 250 tC/ha, includes both above- and below- ground biomass in undisturbed forests. In Table 4.1 a root: shoot ratio of 20% is assumed and is subtracted from the total to give an aboveground biomass carbon estimate of 208 tC/ha.
4. *Brown and Gibbs (2007)* used a rule based GIS analysis to spatially extrapolate forest inventory data from the FAO. This model took factors such as soil, climate, vegetation, topography, land-use information and population density into account, representing "actual" forest carbon stocks for the year 2000. Out of the 4 biome-average estimates in Table 4.1, this model provides the only estimate that accounts for anthropogenic disturbances including land use and degradation, giving a value of 164 tC/ha. This figure is also inclusive of belowground biomass so again, a root: shoot ratio of 20% is assumed and taken from the total, leaving an aboveground biomass estimate of 137 tC/ha.

Country Specific estimates

As shown in Table 4.1, three country specific aboveground biomass estimations are considered:

1. *Brown (1997a)* uses the GIS modelling approach described in the previous paragraph to extrapolate reliable forest inventory data to estimate country specific aboveground biomass. The average aboveground biomass was estimated to be 301 t/ha for Cambodian tropical forests, giving a value of 151 t C/ha.
2. *Sasaki (2006)* produced a model to estimate carbon emissions from Cambodia's production forest from 1993 to 2003. The initial (i.e. 1993) carbon densities are given in Table 4.1. These initial values are based on inventory data collected from central and northern Cambodia. In total, data from 127 plots were used to establish the initial value for production forests (131 tC/ha), 7 plots for protected forest (161 tC/ha), and 22 plots for inundated forest (88 tC/ha). Interestingly, the value for inundated forest is based on unpublished inventory data from Koh Kong province. The model used assumed change in Cambodia's production forest, resulting in a reduction of carbon density from 131 tC/ha to 115 tC/ha over the 10-year model period.

3. *Top et al.* (2006) used forest inventory data obtained from the Cambodian Department of Forestry and Wildlife (now the Forestry Administration) to estimate the aboveground biomass for each forest type in the province of Kampong Thom. The inventory was carried out in 1997 in the Sandan District. Raw data was used from 540 individual forest inventory plots measuring 20 × 60m. Of these 540 plots; 192 were located within evergreen forest, 302 within Semi-evergreen, and 46 within deciduous forest. They also established 15 new inventory plots in re-growth forest not measured in the previous inventory. AGB was estimated for all trees of DBH ≥ 10cm using the method developed by Brown (1997a). The aboveground biomass density (t/ha) results reported by Top *et al.* (2006) were converted to carbon density (tC/ha) in Table 4.1 using a carbon fraction of 50%.

Choice of estimate

The above literature review provides a summary of aboveground biomass, and ultimately, the carbon density estimates for the project area. Depending on which value is chosen, this will have an overriding influence on the entire carbon stock estimation, and in turn, the potential carbon benefits that could be generated by the project.

The 4 biome-average models estimate the aboveground carbon stocks to lie between 126 tC/ha and 208 tC/ha. The lowest estimate value (126 tC/ha), from Achard, aggregates data into one very broad category of "tropical Asian forest", and in doing so, does not distinguish between different ecological zones that exist within Asia. For this reason, this value can be excluded over the more stratified approaches. Houghton (1999) produces figures that are marginally more area specific by dividing tropical Asian forests into 2 ecological zones; *tropical moist* (used for the project area) and tropical seasonal. However, the result of this work gives a very large estimate when compared to the other biome-average figures (208tC/ha). In line with conservative estimation of carbon stocks, this value is considered an outlier and will not be considered for the project area. The higher value can be somewhat attributed to including ground cover vegetation in the calculations. Additionally, this estimate is for completely undisturbed forest.

Gibbs and Brown (2007) appear to have a more applicable figure. They have stratified the tropical Asian forests into 3 ecological zones; *tropical equatorial* (used for the project area), tropical seasonal and tropical dry forests, and also account for anthropogenic disturbances and other critical factors that affect carbon stocks. The IPCC default value could also be applied to the project area. Of the 4 biome-average models, the IPCC have by far the highest level of stratification of ecological zones. Given that little data is available these are the most widely accepted figures used for national carbon inventories. Between the two potentially applicable values, from Gibbs and Brown (2007) and IPCC (2006), the IPCC value of 131 tC/ha is the most conservative and will therefore be the preferred value to take from the biome-average estimates. It must be remembered that biome-average values present the lowest confidence level, or a Tier 1 estimate.

The remaining 3 studies produce country specific estimations and could be considered moving towards a Tier 2 estimate. Brown reports a relatively generous carbon density. This GIS model aggregates all Cambodian forest into one single value, 151 tC/ha. Although the study is country specific, Brown reports that because of the low resolution of the input databases, reporting below the national scale will decrease the reliability of

results, making it unsuitable for the project area. Sasaki's estimate divides forest into production, protected forest and inundated forest. The value for production forest (131 tC/ha) compares well to the IPCC (132 tC/ha) default value and is based on a reasonably large set of inventory plots. However, only 7 plots were used to estimate the protected forest carbon density making this result less reliable. The value for Inundated forest could be used for such forest within the project area as these are based on 22 plots from Koh Kong province.

Top *et al*. (2006) stratifies the forest types into 4 distinct classifications, all of which exist within the project area. The amount of inventory plots used in the measurement should be enough to produce a fairly robust and reliable estimate of carbon density within these specific forest types. If the carbon density estimates for the 3 forest types, evergreen, semi-evergreen and deciduous, are averaged, a value of 132 tC/ha is reached which also compares well to the IPCC values. Nevertheless, because the majority of forest within the project area is evergreen forest (146 tC/ha) the estimate of the total carbon stock for the project area should be higher if Top's values are used over IPCC values.

In conclusion, Top's estimates are country specific, based on a large number of inventory plots, and stratified into distinct forest types that also exist within the project area. Although the inventory plots were not based in the project area, the carbon content of the forest types is likely to be similar. Being country specific estimates, these are preferred by the IPCC over the biome average default values, moving from a tier 1 estimate towards a tier 2 estimate. Tops estimate also compares well to the IPCC value. For the above reasons Tops estimate figures will be applied to the project area forest cover to calculate the average aboveground biomass carbon density[11].

Based on the results from the forest disturbance model and the combination of aboveground biomass figures from Top *et al.* (2006), the average aboveground carbon density for the project area was estimated to be 115 tC/ha.

Belowground biomass

Measuring belowground biomass accounts for the carbon stored in the roots of the forest vegetation. Accounting for this fraction of the carbon pool is not mandatory but it is recommended by existing methodologies (VCS 2007, BioCarbon Fund 2008) as it usually represents a significant fraction of the carbon pool. For example, work by Mokany *et al.* (2006) and Cairns *et al.* (1997) have estimated that belowground biomass is usually found to be approx. 20% of the aboveground biomass. Directly measuring belowground biomass can only be done using very time-consuming methods. Consequently, the use of a regression model based on knowledge of aboveground biomass is more effective and efficient.

[11] As there is a lot of mangrove forest contained in the category "Other forest", the average of the value for forest "Regrowth", given by Top et al. (2006), and the value for "Inundated" forest, given by Sasaki (2006) will be taken for this category (55 tC/ha).

The following regression model developed by Cairns *et al.* (1997) is widely used for tropical forests:

$$BBD = \exp(-1.0587 + 0.8336 \cdot \ln(ABD))$$

Where:

BBD = belowground biomass density (t/ha), and

ABD = aboveground biomass density (t/ha)

By using the aboveground biomass density for each forest category and substituting it into the regression model, and weighting by the respective areas, the average belowground biomass was estimated to be 40.4 t/ha. Using a carbon fraction of 0.5, and a C to CO_2 conversion factor of 3.667, this translates to a value of 20.2 tC/ha.

Total carbon stock

When the aboveground and belowground components of the carbon assessment are combined this results in a total carbon stock estimate of 71,434,476 tC for the project area, equalling to a potential **261,950,222 tCO_2.** The average carbon density is 135.6 tC/ha equalling to a potential **497 tCO_2/ha.**

4.3 Without project deforestation

There are two approaches available to make a quantitative projection of future deforestation for the project area. These are described by the BioCarbon Fund (2008):

a. *Linear projection*: this approach uses information based on historical deforestation trends and simply projects this trend into the future using linear extrapolation. This trend must be lowered in the future scenario if it is expected that expansion of deforestation becomes constrained by unfavourable conditions (e.g. remaining forest land is located on steep slope, poor soil, etc).

b. *Modelling approach*: using this approach, future deforestation is modelled as a function of independent deforestation driver variables. The model is calibrated and validated using historical data on key driver variables that are expected to change during the project lifetime. The model can be adjusted accordingly between each crediting period.

The linear projection approach is suitable when current conditions within the project area are not expected to change significantly over the project lifetime. If the linear projection cannot be well justified, and conditions are expected to change significantly in the project area, the modelling approach is more appropriate. Due to the mounting pressures on the forest within the Southern Cardamoms (see Chapter 3), conditions are expected to change, resulting in increased deforestation in the future. For this reason the modelling approach is ideally preferred. However, due to the limitations of this study, a comprehensive model could not be made. Instead two "without" project deforestation scenarios will be presented:

1. *Linear scenario:* historical deforestation within the project area will be analysed and will represent a lower boundary "without" project deforestation rate and,

2. *Dynamic scenario:* in an attempt to create a possible future scenario we will analyse trends in the region surrounding the project area where deforestation has already had a heavy impact. This larger region surrounding the project area can be referred to as a reference region. A reference region can give an indication of how deforestation in the project area may be expected to increase in a future scenario and can therefore be used to adjust project area baseline deforestation. In this study, deforestation in the reference region will represent an upper boundary "without" project deforestation rate for deforestation in the project area.

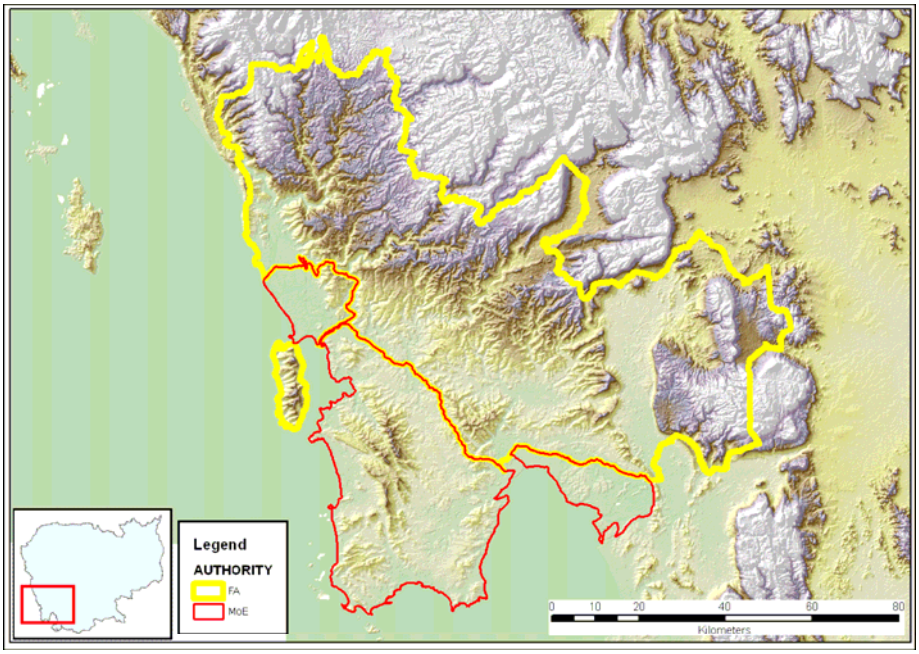
The starting points for both "without" project deforestation rates will be an analysis of historic deforestation in the Southern Cardamom Ecosystem. Due to the limitations of the available FA data, an independent study was done to estimate the actual net deforestation.

Deforestation in the Southern Cardamoms

Ideally, to uncover the gross deforestation rate for the project area, historic forest cover and land use maps must be analysed in series, over a defined period of time known as a reference period. The reference period should be not more than 10 – 15 years in the past and be as close as possible to the start date of the project. It is recommended as good practice that maps are made for at least 3 points in time during the reference period and about 3-5 years apart (BioCarbon Fund 2008). The information gathered from this series of maps can then be used to project a linear "without" project deforestation rate or alternatively the information can be used as input to model a future deforestation for the region.

An estimation of gross deforestation was made by Aruna Technologies (Aruna 2008), a remote sensing and GIS consultancy based in Phnom Penh. The details and results of the study are described below.

The study area, depicted in Figure 4.4, is commonly known as the Southern Coastal Cardamoms. This area encompasses the complete project area - controlled by the FA, the MOE protected areas to the South, and Koh Kong Island.



Source: Aruna (2008)

Figure 4.4 Study area – Southern Coastal Cardamoms.

Satellite imagery from LandSat (30 x 30 m resolution) was used for the study. Four individual images were analysed in series over the following time periods:

Year	Date
1. 1991	20th November 1991
2. 1998	07th January 1998
3. 2002	10th January 2002
4. 2005	07th March 2005

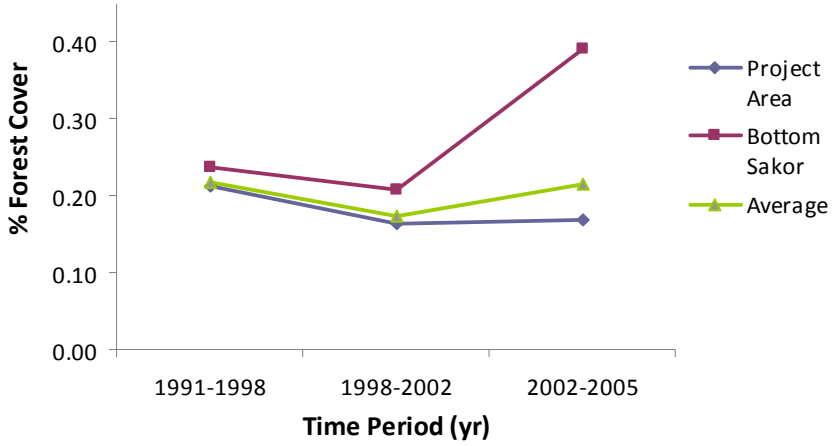
Areas of clearing were identified by comparing specific spectral indices of each image to the previous one[12]. The minimum mapping unit (MMU) used for the study was 2 ha, allowed for by the resolution of the imagery. Due to difficulties separating the spectral indices of clearing of dense forest and clearing of shrub land, the areas of clearing were merged with the FA's forest classification of the original year to establish what kind of forest was lost, and distinguish between "forest" and "non-forest". Cleared areas that were identified as "non-forest" from the FA classification, were then eliminated to leave cleared "forest" areas.

The results of the study are shown in Figure 4.5 and Table 4.2 (in Appendix III a map showing the geographical distribution of the forest clearance can be found). Forest clearing from Koh Kong Island was omitted from the results shown below, as it is geographically distinct from the rest of the study area. This omission accounted for clearing between one time periods only (i.e. 1991-1998), and measured a marginal 35 ha in total.

The analysis shows some interesting trends. There was a relatively high total deforestation rate in the period between 1991 and 1998. This can be attributed to the intensive

[12] For details of the processing techniques and limitations, refer to Aruna (2008).

logging activity in the area at the time. The total deforestation rate then drops by almost 300 ha/yr between 1998 and 2002, with a decrease of 256 ha/yr (86 percent) accounted for within the project area. The period between 2002 and 2005 is most interesting. There is an increase in the total deforestation rate of 286 ha/yr, with the MOE area accounting for 257 ha/yr (90 percent) of this increase. Over the last two time periods, the steady deforestation rate in the project area (0.16→0.17 percent/yr), compared to the sharp rise in the MOE area (0.21→0.39 percent/yr), is most probably due to the efforts of Wildlife alliance, operating in the project area since 2002. If the deforestation rate in the project area had increased by the same magnitude as it did in the MOE area, a further 630 ha of forest would have been lost each year during 2002-2005.



Data source: Aruna (2008)

Figure 4.5 Annual rate of forest clearing (ha) over given time periods.

Table 4.2 Results from gross deforestation analysis, Aruna (2008)

	1991-1998 [a]	1998-2002	2002-2005 [b]	Forest cover 2005 (ha)
MAFF				526,608
Total forest cleared (ha)	6,859	3,457	2,830	
ha/yr	1,120	864	894	
% of remaining forest cover	0.21	0.16	0.17	
MOE				138,948
Total forest cleared (ha)	2,017	1,153	1,726	
ha/yr	329	288	545	
% of remaining forest cover	0.24	0.21	0.39	
MOE and MAFF				665,556
Total forest cleared (ha)	8,876	4,610	4,556	
ha/yr	1,449	1,153	1,439	
% of remaining forest cover	0.22	0.17	0.22	

[a] The 1991 LandSat image was form mid-November, while the 1998 image was from the beginning of January. Therefore, the annual deforestation rates for this period were calculated by dividing the total by 6.125 years.

[b] The 2002 LandSat image was from early January, while the 2005 image was from early March. Therefore, the annual deforestation rates for this period were calculated by dividing the total by 3.167 years.

Based on figures in Table 4.2, the average gross deforestation rate for the project area is estimated to be **0.19 percent/yr**[13]. This deforestation rate is relatively low. It was argued in Chapter 3 that this deforestation rate does not serve as a realistic representation of what is likely to evolve in the future "without" project scenario. The estimate of 0.19 percent/yr will therefore represent the lower boundary "without" project deforestation rate and be projected linearly into the future. In the following section, deforestation trends in the region immediately surrounding the project area will be discussed to indicate what the potential upper boundary deforestation rate for the dynamic "without" project should be.

Deforestation in the surrounding provinces

Considering the discussion on the national forest cover statistics provided in Appendix XI, despite limitations, the forest cover statistics published by the FA for 2002 – 2005/06 (FA 2008) may serve a purpose to estimate deforestation rates within the provinces surrounding the project area. These provinces could be considered collectively as a larger reference region and may indicate how future deforestation may develop. Table 4.3 provides forest cover statistics for the project area province (Koh Kong) and for each of the surrounding 5 provinces. Note that the following deforestation rates are reported in a similar fashion to that of the Aruna (2008) i.e. as a percent of remaining forest cover.

Table 4.3 Forest cover, forest cover change, and net deforestation rates for a selection of Cambodian provinces.

Province	Total area (ha)	Change 2002-2005/06 (ha)	Deforestation (%FC/yr)
Koh Kong	1,211,595	153	0.01
Kampong Speu	696,471	14,911	1.21
Kampot	471,815	8,625	1.27
Pursat	1,158,591	2,787	0.10
Preah Sihanouk	149,205	2,575	1.04
Kampong Chhnang	529,461	4,583	0.73
Total	**4,217,138**	**33,634**	**0.40**

Note: The Deforestation rate (%FC) was divided by 3 to give the annual deforestation rate. This was done because the acquisition dates for the LandSat images that were used for the 2005/2006 map, were all from early 2005 for this area.

Source data was taken from the FA - *Cambodia forest cover* (2008a) for the 2005/06 figures, and from a published Khmer FA document for the 2002 figures (FA 2004).

As can be seen in Table 4.3, Koh Kong province is clearly the region with lowest net deforestation, showing only a marginal decrease in forest cover (0.01 percent/yr). The neighbouring provinces have a much higher net deforestation rate (around 1 percent/yr), with the exception of Pursat. The average net deforestation for the entire region is 0.4 percent/yr of forest cover. Due to the relative size of Koh Kong province and its negligible net deforestation rate, its inclusion has a significant effect on the average. If Koh Kong province is left out equation, the above total average net deforestation is approx. **0.6 percent/yr.** As this figure represents net deforestation for the surrounding provinces, it is very likely below an estimate for gross deforestation. This figure can

[13] The exact deforestation rate used in the calculations was 0.188 percent of remaining forest cover. This equalled to 990 hectares/yr

therefore be considered a conservative estimate of gross deforestation for the region and will form the basis for the dynamic "without" project deforestation rate.

Without project deforestation scenarios

The Linear "without" project scenario can be considered a highly conservative scenario. The average historic deforestation rate found for the project area **(0.19 percent/yr)** will be projected as constant over the project lifetime. The dynamic "without" project scenario attempts to give a picture of what could happen in the future, given the mounting pressures that were described in Chapter 3. It can clearly be seen how fast the deforestation rate can accelerate from the analysis of deforestation in the SCE, given that the deforestation rate in the MOE area almost doubled in the last time period measured. The net deforestation rate for the surrounding provinces **(0.6 percent/yr)** will form the basis of the dynamic deforestation scenario. The deforestation rate in this scenario will gradually increase from 0.19 percent/yr over the first 10 years. After this point the deforestation rate will level off and gradually decline due to the most favourable land being already cleared. The average deforestation rate over the project lifetime will be 0.6 percent. Figure 4.6 shows a graphical representation of both deforestation scenarios over an assumed 30-year project lifetime.

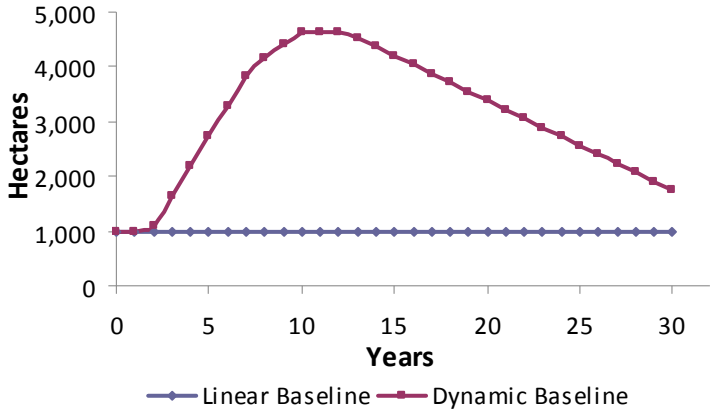


Figure 4.6 "Without" Project deforestation scenarios over 30-year project lifetime

4.4 REDD carbon potential

Without project emissions

The analysis provided in Chapter 3 highlights the growing pressures affecting the project area in the coming years and decades. Without intervention, this scenario is likely to have a devastating impact on forest cover in the region as witnessed in other regions of Cambodia and Southeast Asia. In the absence of the REDD project, there will be less patrolling to deal with the rising pressures as well as diminished incentives for the government to keep the forest standing. Communities will continue to rely on traditional practices and could eventually exhaust the surrounding natural resources. The earlier analysis argues that the historical deforestation trend within the project area does not serve as a realistic representation of what is likely to unfold in the future. Therefore, in the following quantification of future carbon emissions in the "without" project setting,

two "without" project emission scenarios are presented:

- *Linear Scenario***:** the average deforestation rate estimated for the project area by Aruna will be projected as a conservative lower bound estimate using a constant rate of 0.19 percent/yr over the next 30 years
- *Dynamic Scenario***:** a dynamic deforestation rate that will increase steadily over the next 10 years. After reaching this point, it will level off and gradually decrease for the next 20 years due to the most favourable lands being already deforested. The average deforestation rate over the 30 year period will be 0.6 percent/yr.

Based on the proximate drivers of deforestation, the replacing land uses given in Table 4.4 are assumed. For both "without" project scenarios the replacing land uses and the percenttages remain the same. Once the forest is cleared, all carbon contained in the above and belowground biomass is assumed to be released to the atmosphere in the form of CO_2, as consistent with IPCC default recommendations (IPCC 2006). The replacing land uses and their corresponding carbon stock are assumed to take immediate effect after deforestation, and are therefore subtracted from the total emissions to give the net emission rate for each scenario.

Table 4.4 Assumed percentages of replacing land uses and their carbon content.

Replacing land uses:	Percentage	Type of land	Carbon Content	Source
Agricultural concessions	65%	Sugarcane[14]	12.5	(Lasco 2002)
Shifting cultivation	25%	Shifting cultivation	32.5	(Lasco 2002)
Wood extraction	10%	Brushland	29	(Lasco 2003)

Table 4.5 provides the estimates of the amount of CO_2 emissions for both "without" project scenarios. The table displays the quantity of CO_2 emitted in 5-year intervals, over a 30-year time span.

Table 4.5 Estimates of CO_2 emissions in 5 year intervals over a 30 year period for both "without" project scenarios (Baseline Emissions (000, tCO_2).

Year	1-5	6-10	11-15	16-20	21-25	26-30	Total
Linear Sc.	2,036	2,036	2,036	2,036	2,036	2,036	12,215
Dynamic Sc.	3,554	8,360	9,203	7,641	5,956	4,270	38,984

Under the linear scenario, the total forest cover is reduced by 0.19 percent/yr, or 990 hectares/yr, at a constant rate for the next 30 years. Using this constant rate, the average annual emission rate is equal to approx. 407,000 tCO_2/yr, totalling 12.2 million tCO_2 over a 30-year period.

[14] Sugarcane has been chosen since it is the crop that has the best growing conditions in Koh Kong. A large sugarcane concession (20,000 ha) has already been issued in the project area in 2006.

Under the dynamic scenario, the increasing deforestation rate produces increasing CO_2 emissions. Between year 11 and 15, the emissions reach a maximum and the emission rate begins to fall. This scenario produces an average emission of 1,299,000 tCO_2/yr, or a total of 39 million tCO_2 over a 30-year lifetime.

The two scenarios present two very different results. The Linear scenario can be seen as a highly conservative estimate given the future pressures described in the chapter 3. In contrast the Dynamic scenario attempts to replicate a deforestation rate that could easily unfold without REDD intervention. In the Technical Assessment it was shown that between 2002 and 2005 the annual deforestation rate almost doubled in the Botum Sakor, MOE Protected Area. This serves as a good example of just how rapid the change can be.

With project emissions

To calculate the carbon emissions for the "with" project scenario it has been assumed that the REDD project will be fully implemented by year 2018. When the project is fully implemented, only minimal deforestation will occur. A deforestation rate of around 0.01 percent/yr has therefore been assumed, equalling approximately 50 ha/yr. This is assumed to be the minimum deforestation rate achievable, taking into account the possibility of small-scale development, population growth etc. The current deforestation rate of 990 ha/yr will therefore, decrease linearly until year 10 where the project is fully implemented. At this point the deforestation rate of 50 ha/yr will remain constant for the coming 20 years of the projects lifetime. The replacing land use is assumed to be the same as in the "without" project scenario, since the drivers of deforestation is expected to be similar but on a smaller scale.

Table 4.6 CO_2 emissions in the "with" project scenario (000, tCO_2).

Year	1-5	6-10	11-15	16-20	21-25	26-30	Total
	1,457	494	109	109	109	109	2,386

It should be stressed that the minimum deforestation rate only will be attained if all drivers and agents of deforestation in the ecosystem are addressed adequately. The project is promising, but does have some weaknesses that can result in reduced volume of carbon credits. These risks and weaknesses will be described later in the section as well as in the *Recommendations* chapter.

Total carbon potential

Based upon the "without" and "with" project emissions presented, the total avoided CO_2 emission for the REDD project can be estimated. Table 4.7 provides a summary of the emission reductions in five-year intervals, over a 30-year period for the two scenarios.

Table 4.7 CO_2 emission reductions in the "with" project scenario (000, tCO_2).

Year	1-5	6-10	11-15	16-20	21-25	26-30	**Total**
Linear Sc.	579	1,542	1,927	1,927	1,927	1,927	**9,828**
Dynamic Sc.	2,097	7,866	9,094	7,532	5,847	4,161	**36,597**

The conservative linear scenario is estimated to avoid almost 10 million tCO_2 over the 30 year period averaging approx. 330,000 tCO_2/yr. The project reaches maximum carbon credit generation after 10 years due to full implementation of the REDD project activities.

The dynamic scenario produces approx. 36.6 million tonnes of avoided CO_2 emissions over the 30-year period averaging 1,220,000 tCO_2/yr. The maximum carbon credit generation is reached between year 11 and 15 due to the "without" project deforestation rate peaking during these years.

The above figures indicate significant opportunities for generating carbon benefits. However, these figures represent total potential. There are a number of issues that may well reduce this potential, namely; additionality, leakage, and permanence.

Additionality

One potential challenge that could represent a significant obstacle to the REDD project is the issue of additionality. A project is seen as additional if project proponents can prove that the net GHG emissions are reduced below what would have occurred in the absence of the REDD project activity. This may present a challenge because Wildlife Alliance has been working in the project area since 2002, and has decided only recently to seek carbon credits for their conservation efforts. Considering this, will future emission reductions be seen as lower than the business as usual scenario, and therefore additional?

There are a number of tools project proponents can use to demonstrate that the project is additional. BioCarbon Fund (2008) recommends using the latest version of the "Tool for the demonstration and assessment of additionality for afforestation and reforestation CDM project activities" approved by the CDM Executive Board. The VCS (2007) also provide guidance form demonstrating additionality. There are a number of issues that must be considered. First, one of the main requirements is that the project activities must not be required by law; otherwise project proponents must make a compelling demonstration that the pertinent laws are not being enforced (CCBA 2005, VCS 2007). Second, Wildlife Alliance has been implementing deforestation-reducing activities from 2002 to present date. If Wildlife Alliance wants to claim carbon benefits for these earlier activities, it must be prove that the REDD project has already started. Evidence must be provided that the incentive of the planned sale of GHG emission reductions was seriously considered in the decision to proceed with the earlier project activity. Otherwise these earlier activities will not be considered additional and therefore no carbon benefits can be claimed. The evidence to prove these earlier activities are additional should be based upon official, legal, and /or other corporate documentation that was made available to third parties prior to the start date of the project activity. Finally, it must be proven that the REDD project activity faces certain barriers preventing implementation without revenues generated from the sale of carbon credits. See Appendix X for a thorough discussion of the steps to prove additionally.

Leakage

Project leakage must be accounted for. If more deforestation is detected in the surrounding area compared to what the situation was prior to REDD project implementation, this is considered leakage and must be subsequently subtracted from the

net emission reductions. Leakage is measured by analyzing deforestation trends within the leakage belt. The leakage belt is the geographic area adjacent to or surrounding the project area in which displacement of baseline activities from inside to outside the project boundary are likely to occur. Figure 4.7 shows an example of what the leakage belt could look like for the project area.

Leakage is intrinsically linked to deforestation. If the factors contributing to deforestation are properly identified and understood, much of the potential leakage can be minimized in the project design (Aukland *et al*. 2002). This is done by directly targeting the agents and drivers of deforestation in the project area so that the problem is solved at the root cause. Leakage prevention measures will usually take the form of providing alternative livelihoods. Project activities such as the CADP, sustainable agricultural development and education, eco-tourism, and Community Forestry, each contribute to leakage minimization, but may not be enough to prevent it completely.

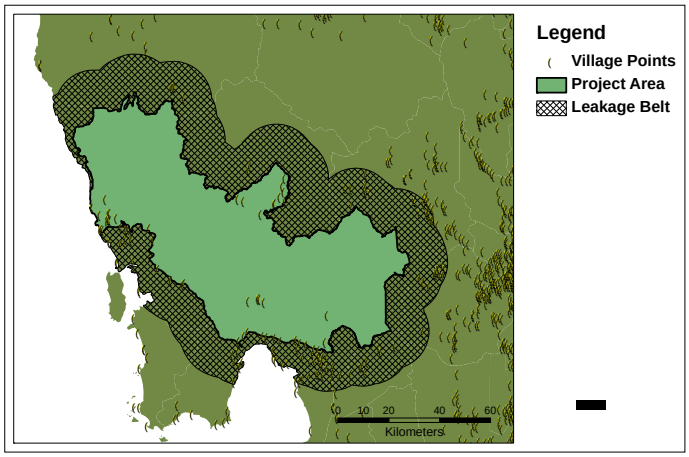


Figure 4.7 Example of leakage belt around the project area

Quantifying and assessing leakage ex ante is difficult, as the amount of leakage will largely depend on how many baseline deforestation agents can be provided with alternative livelihoods. Locations in the project area where villages are situated close to the project boundaries are particularly susceptible to leakage as villagers can easily migrate outside the project boundary if though restrictions are enforced. It must be noted that most of the surrounding forested land is protected in some form, and would therefore not give much incentive for villagers to migrate, unless of course enforcement in these areas is weak.

Permanence

Permanence of the carbon benefits is directly related to the amount of "risk" that can be attributed to the project as a whole. A primary source of risk for the REDD project is social acceptability. Peskett *et al*. (2008) explains that past attempts to stem deforestation have shown that if marginal communities benefit from the project activities, they can be convinced to become pro- forest conservation i.e. guardians of the forest. However, if communities do not feel that they are benefiting, but suffering inequalities, they can become especially anti-forest conservation, and destructively so.

To mitigate the risk of non-permanence, it is required to reserve a fraction of the carbon credits in a "buffer" account so that long term emission reductions are secured. The amount of carbon credits required to be kept in reserve will depend on the amount of non-permanence risk involved i.e. the higher the risk → higher amount of reserve credits demanded. The VCS (2007) has developed guidance on risk factors and risk ratings for REDD projects. Projects with "High" risk are recommended to keep 20-30% of carbon credits in a buffer account, "Medium" risk 10 – 20%, and "Low" risk 5 – 10%. In general, projects that have lower risk, correspond to projects that deliver both social and environmental benefits. These projects are more likely to receive approval from government and local communities, are favoured by investors, generate more credits for sale, and can attain higher price for each credits.

4.5 Summary

The average carbon density for above- and belowground biomass pools was estimated to be 135.6 tC/ha, equalling a potential gross emission of 497 tCO_2/ha if deforestation occurs. Considering this carbon density and the assumptions made on deforestation rates and replacing land uses in both the "with" and "without" project scenarios, the total potential for REDD carbon is estimated to be between 10 and 36.6 million tCO_2 over the 30 year period. These estimates represents the technical potential only and may well be reduced depending on influencing factors such as additionality, leakage and permanence of emission reductions. While there is a developed framework to demonstrate additionality, securing emission reductions and minimizing leakage and permanence will largely depend on the institutional and social conditions prevailing in the area as well as project design.

5. Institutional assessment

The aim of this Chapter is to describe the main institutions, policies and laws that will set the framework for the REDD project. The Chapter begins by introducing the relevant governing bodies and institution, and describing the current policy climate for REDD carbon projects. This will be followed by a description of the two major pieces of legislation that influence the forestry sector, the Land Law, and Forestry Law. The Chapter will finish by examining how the relevant institutions and laws affect the project area.

5.1 Forest relevant institutions

On the national scale, Cambodia is governed by a traditional state-centred hierarchical structure. The entire system is characterized by many overlapping ministries and institutions of varying power structure and influence. There are five levels of state governance; state-provincial-district-commune-village, with each rise in level typically possessing dominance over the lower level. However the levels below provincial government have limited influence over the management regime of the forestry sector. Due to the dominance of the state in the forestry sector, the focus will be on the relevant national institutions: The Forestry Administration, The Ministry of Environment, The Technical Working Group on Forestry and Environment, and the cooperating NGO, Wildlife Alliance.

The Forestry Administration (FA): Cambodian forested land falls under the general jurisdiction of the Ministry of Agriculture, Forestry and Fisheries (MAFF). FA was formed within this ministry in 2003, and is the government authority for the management of forest and forest resources according to the National Forest Sector Policy (2002) and the Forestry Law (RGC 2002a). The FA, through MAFF, is linked to the Ministry of Planning (MOP) and the Ministry of Economy and Finance (MEF). Revenues generated by the FA flow back into the MEF, who in turn provides the FA with its annual budget. The FA and MAFF will be the key government institutions involved in the REDD project.

The Ministry of Environment (MOE): While the FA holds the responsibility to manage the nation's forest estate, the management of protected areas has been delegated to the MOE by provisions stated in the Environmental Protection and Natural Resources Management Law (1996), and the Royal Decree on the Establishment and Designation of Natural Protected Areas (1993). Protected areas include national parks and other natural reserves, including those containing forest. MOE does not have any direct influence on the project area but are administrating the majority of the surrounding areas (see Figure 5.2).

The Technical Working Group on Forestry and Environment (TWG-F&E): TWG-F&E[15] was established in 2004 to provide a mechanism for government-donor coordination to support and strengthen development activities within forestry and environment. The TWG-F&E also provides technical support to the Cambodian government in identifying priority areas, harmonizing activities, and improving the utilization and mobilization of

[15] See www.twgfe.org for more details.

available resources to strengthen the sector's capacity and ultimately, contribute to economic growth. The TWG-F&E has developed a recently approved four-year action plan for forestry and environment 2007-2010. The primary objective of this plan is to develop a National Forest Programme (NFP) in order to create and implement a long-term strategy for the nation's forest sector.

Wildlife Alliance: Wildlife Alliance is an NGO operating in the Southern Cardamoms. Since 2002 they have been working with the FA in the project area, protecting the forest and its biodiversity, and establishing various programs for community development. The REDD carbon project will form an important part of an integrated Master Plan that Wildlife Alliance has developed for the area in collaboration with the FA. Wildlife Alliance also supports protection activities to the south of the project area in the MOE, Botum Sakor National Park.

5.2 National forest policy

The above-mentioned institutions are guided by the national policy on forestry. The forest policy provides a template for the future direction of the national forestry sector and highlights some of the weaknesses and obstacles the sector faces for future development.

The primary guidance document for the forestry sector is the **"**Statement of the Royal Government of Cambodia on National Forest Sector Policy" (RGC 2002b). This policy outlines the national goals with regard to the management of forest resources and gives encouraging signs for future REDD activities;

> *"The Royal Government of Cambodia considers the ecologically, socially and economically viable conservation and management of forest resources as a major pillar of public welfare directly contributing to environmental protection, poverty reduction and socio-economic development"(RGC 2002b).*

Throughout this document there is a strong emphasis on forest conservation and sustainable management, aiming to maximize the sectors contribution towards poverty reduction, food security, and equitable socio-economic development. The promotion of good governance is also underlined, with the need for capacity building and the strengthening of government institutions recognized. One of the goals outlined is "to optimize the benefits to local populations from the use and management of forest resources". This gives an indication that the benefits generated from REDD activities may not only contribute to government revenues but may also be channelled back into community development and poverty reduction.

As part of the national policy, the government has committed to prepare a National Forest Programme to promote conservation and sustainable management and use of forests. This programme is the top priority of the TWG-F&E and is outlined in the four year TWG Action Plan 2007-2010. The programme encourages multi-stakeholder participation from local to international levels, aiming to streamline the forest sector, improving planning, programming, implementation, and evaluation of forest activities (RGC 2008b). The NFP focuses on six programmes that can each contribute to the success of future REDD activities: Forest Demarcation, Sustainable Forest Management,

Community Forestry, Law Enforcement and Governance, Capacity development and research, and Forestry and Climate Change.

Although all of the above programs have an important role to play in the success of REDD projects, there are three programs worth discussing in more detail.

- *Forest Demarcation:* The boundaries of Cambodia's forest estate have never been properly demarcated or registered, leading to uncertainty when attempting to protect the forest against illegal land grabbing and encroachment from speculators and local villagers. The FA is currently running pilot demarcation projects in four provinces but aims to eventually scale up the programme to national level.
- *Community Forestry:* In an attempt to give local communities some control over their surrounding natural resources, the FA has developed a coherent Community Forestry programme over the past five years. There have been a number of pilot Community Forest sites to date, and there is a strong growing demand for others. The FA is aiming to allocate 20% of the forest estate to Community Forestry agreements and attendant management plans by 2020. This programme will not only give locals much needed access to forest resources but also help protect the forest against excessive degradation and illegal activities.
- *Forestry and Climate Change:* With regard to political support and commitment to forest carbon programs, the Cambodian government is showing keen interest in developing REDD conservation projects. The government believes that the REDD framework can "contribute to alleviating poverty, improved governance, and sustainable forest management in Cambodia, as well as mitigating global climate change" (Forestry Administration 2008b). The first pilot REDD project has just been approved for a number of Community Forest sites in Oddar Meanchey Province[16], in conjunction with Community Forestry International (CFI) and Danida. As part of the agreement made with the RGC, the FA is designated as the seller of forest carbon.

The Memorandum of Understanding (MOU) between CFI and the Cambodian government contains two important features (RGC 2008a):

- The FA allows CFI to identify buyers and explore terms and carbon prices.
- Revenues from carbon sales will be used to:

    a. Improve the quality of the forest;
    b. Maximize the benefits to local communities participating in the project; and
    c. Study potential sites for new forest carbon REDD projects.

Revenues generated by the project will be channelled through the TWG-F&E during the first five years of the project (RGC 2008a). The FA is also exploring future potential Afforestation and Reforestation pilots in collaboration with the MOE and the Cambodian Climate Change Office.

The above policies create an encouraging climate for REDD projects in Cambodia. Nonetheless, these policies will have limited effect without proper implementation and a sustained effort from both government and external institutions. There exist a number of inherent barriers that may hamper further progress. First, the most significant obstacle is

[16] Oddar Meanchey Province is situated in the north-west Cambodia.

the issue of widespread governmental corruption, reported by multiple sources (Calavan *et al*., 2004; UN, 2007; Global Witness 2007). The root of this stems from several contributing factors including; the dominance of the traditional hierarchical governance structure, a weak judicial process, low paid workforce, and a system shrouded in secrecy, absence of transparency and lacking accountability. Second, the issue of insecure property rights of the poor, and the corrupt distribution of land titles and concessions to the powerful elite, is a point of major concern. Lack of clearly defined property and user rights, coupled with an unclear land management system, increases the amount of "risk" that can be attributed to REDD projects and lowers investors' interest. Finally, there seems to be a lack of communication and cohesion between the country's two main forest governing bodies – the FA and the MOE. These barriers to progress represent a significant challenge to the implementation and investment in forest carbon project.

5.3 The land law

The Land Law classifies the different types of property that exist in Cambodia, and their corresponding ownership rights. It also provides important provisions for land management, in the form of indigenous land rights and social and economic land concessions. This law, and related regulations, will therefore define who owns the legal right to the carbon credits generated by the project, and give insight to the status of local land tenure.

Land ownership

The Land Law (RGC 2001) provides a system in which land can be legally classified into distinct groups each with its own specific ownership possibilities. There are three relevant elements of this classification system for the forestry sector:

1. *State Public Property:* State Public Property is land that carries a public interest and is held by the state in public trust. Article 15 describes seven categories of State Public Property of which two are relevant for forested lands: (i) "Any property that has a natural origin, such as forests, courses of navigable or floatable water, natural lakes, banks of navigable and floatable rivers and seashores"; and (ii) "Any property that constitutes a natural reserve protected by the law". This category of land may not be sold or transferred to any other entity as long as it holds its public interest. It may, however, be subject to temporary occupancy for logging concessions. If the land loses its public interest, it may be reclassified as State Private Property.
2. *State Private Property:* State Private Property is land that is owned by the state or public entity that does not hold a public interest. The main difference between State Private and State Public land is that the former "may be the subject of sale, exchange, distribution or transfer of rights as it is determined by law" (Land Law (RGC 2001), Article 17). All land concessions can only be issued on State Private Property.
3. *Indigenous Property under Collective Ownership:* There are two parts to this land category; 1) Monastery Immovable Property, and 2) Immovable Property of Indigenous Communities. Only part 2 is relevant for REDD. The lands of indigenous communities are lands where communities have established their residences and where they carry out traditional agriculture. It also includes an excess of lands that should be reserved for shifting cultivation. Land that is granted by the state to com-

> munities under the collective ownership includes all the rights and protections that are enjoyed by private owners. However, the community does not have the right to dispose of any collective ownership that is State Public property to any person or group (IFSR 2004).

Another important element of the land law is that of Private ownership for settled Cambodians. Under the land law, any person who enjoyed peaceful, uncontested possession of land – but not state public land – for more than five years prior to the law's promulgation has the right to request a definitive title of ownership. People who have enjoyed such possession for less than five years may obtain a title of ownership after five years have passed (RGC 2001). Although this law encourages land title ownership, the reality is that the vast majority of rural Cambodians do not have land title documents that recognize ownership of their land, either because they cannot afford the transaction cost, or because they do not see the need to go through the uncertain bureaucratic procedure (UN 2007).

Land concessions

Besides defining the various aspects of property rights, the Land Law also provides for different land management options in the form of land concession, which have a major impact on land tenure and land use. Chapter Five of the Land Law (RGC 2001) provides provisions for the granting of land concessions in response to social or economic purposes. This form of concession can be given to any person, legal entity, or group of persons and entitles them to occupy the land and exercise the rights set forth by the Land Law. The procedure for granting either social or economic land concessions is determined by separate sub-decree. These two forms of land concession have varying implications for land-use and land-use change in Cambodia.

Social land concession

Social land concession is defined as a "legal mechanism to transfer Private State land for social purposes to the poor who lack land for residential and/or family farming purposes" (RGC 2003). This essentially means that the state may grant land to eligible heads of poor families that are in need of land to build residence or to cultivate lands belonging to the State for their subsistence. The social land concession initially carries a grant of occupancy and use only. However, if the occupier complies with the criteria of the concession program for five years, the right to obtain an ownership land title is earned.

Social land concessions have an important role to play for local communities. If future population growth causes land scarcity within the community boundaries, the social land concession system provides a coherent mechanism so that the commune council can apply to the authorities for community land expansion.

The social land concession system could have both negative and positive effects on forest. On the one hand, social land concessions can only be granted on State Private property. In much of Cambodia, State Private and State Public land are not clearly demarcated or registered. If it is the case where land-use within the village boundary is already maximized, this may encourage people to clear forest land (i.e. State Public land) on the periphery of the village so that they could in turn apply for a social land concession in the future.

On the other hand, the social land concession system can be positive for local communities and forest conservation if not abused. It must be noted that the Social Land concession system is in its infancy and for the moment very few concessions have been granted. It is also expected that this form of land concession has, and will have, a minor impact on land use patterns in Cambodia when compared to that of the larger scale of economic land concessions.

Economic land concession

Since 1996, almost one million hectares of land have been granted to large-scale economic land concessions. This system has been heavily criticised for breaches in the law and their impact on human rights and rural livelihoods (UN 2007, Bristol 2007, Calavan 2004). The Land Law authorizes the granting of land concessions for economic purposes through the Sub-decree on Economic Land Concessions (RGC 2005). These concessions can again, only be granted on State Private property, for agricultural and/or industrial-agricultural exploitation.

Despite the existence of a rigid legal framework, there is a gross divergence between law and practice. Essential pre-conditions to the granting of concessions, such as the conduct of public consultations and social and environmental impact assessments, and the Registration of land as State Private Property, have often not been fulfilled. Similarly, rules regulating the size and ownership of concessions are rarely being enforced. Concessions are even being granted in forested land (i.e. State Public Property), which is in violation of the Forestry and Land Laws. The Ministry of Agriculture Forestry and Fisheries has commented that it is difficult to comply with all requirements of the sub-decree when facing pressure from investors. Government officials have said that if they were to wait until all legalities were met prior to the granting of concessions, companies would lose interest in investing in Cambodia (UN 2007).

Commonly cited impacts of economic concessions on local communities are (UN 2007):

- Encroachment of forest and loss of access to non-timber-forest-products (ntfps);
- Encroachment on agricultural and grazing land;
- Displacement of communities and environmental destruction;
- Impact on areas of cultural and spiritual significance.

Besides the social impacts mentioned above, economic land concessions have a huge potential to impact forest cover loss, especially when granted within forest estate. Due to blatant abuse from the authorities and business elite, the entire system creates an unfavourable atmosphere of mistrust and resentment between locals, and government institutions.

5.4 The forestry law

The Forestry Law (RGC 2002a) is the primary legal instrument for the Cambodian forest sector. This law defines forest classifications, management systems, and rules and regulations regarding forest concession management, community forestry, forest crimes, and traditional user rights. It also outlines the structure, functions and responsibilities of the FA who has jurisdiction over the national forest estate. The most relevant elements of the forestry law are described in the following.

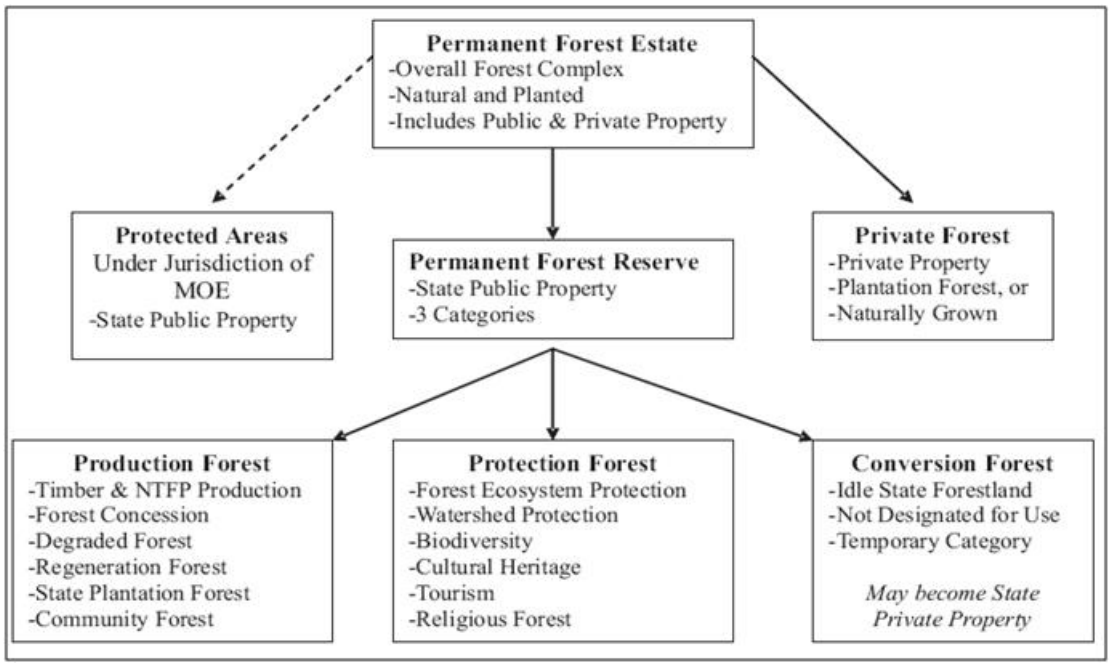
Forest classification

The Forestry Law provides a separate classification system for forested lands and defines the different use options available under each forest category. It also relates each forest category to the corresponding land classifications defined by the Land Law (State Public, State Private etc.). The Forestry law states that all forest land within the Kingdom of Cambodia lies under the category of Permanent Forest Estate. This overarching category can be divided into Permanent Forest Reserve or Private Forest.

Private forests are considered forest that is located on Private Property, as described in the Land Law. Permanent Forest Reserve consists of forested land that is located on State Public Property. Permanent Forest Reserve can be further divided into 3 sub-divisions:

- *Production Forest*: Is described in the forest law as: "Forest area having the primary function for sustainable production of Timber and Non-Timber Forest Products. Production forests includes forest concession; forest permitted for harvesting, degraded forest, forest to be rehabilitated, reserved area for forest regeneration or forest plantation, reforested areas and forest areas under agreement between the Forestry Administration and the local community" (Forestry Law (RGC 2002a), p. 39). Production Forests should be maintained in a manner to allow for the sustainable production of forest products and by-products, with their protection considered of secondary importance.
- *Protection Forest*: Is defined within the forest law as "Forest area having the primary function for protecting the forest ecosystem including the water resources regulation; conservation of biodiversity, land, water, watershed and catchments areas; wildlife habitat, fishes, prevention of floods, erosions, sea water intrusion; soil fertility and valuable for cultural heritage which serve the public interests." (Forestry Law (RGC 2002a), p. 39). Protection Forest under the Forestry Law does not include Protected Areas. Protected Area fall under the jurisdiction of the MOE are considered State Public Property under the Land Law.
- *Conversion Forest*: Is defined as: "Idle State forestland, covered mainly by secondary vegetation, not yet designated for any use that shall be classified temporarily as Permanent Forest Reserve" (Forestry Law (RGC 2002a), p. 39). Although Conversion Forests are classified as part of the Permanent Forest Reserve, and is therefore State Public Property, it can be potentially reclassified and removed from this classification. If this is done, the land would most likely become State Private property. This means that the reclassified land could then be used for land concession or sold (IFSR 2004).

Figure 5.1 summarizes the forest categories and their corresponding property status.



Source: Oberndorf (2006).

Figure 5.1 Forest categories of the Cambodian Forestry Law 2002.

A significant weakness in the forest/land classification system is the lack of clear definitions. First, a fundamental flaw is that there is no fixed definition of forest. This will inevitably lead to complexities when attempting to demarcate the Permanent Forest Reserve. Second, similar definitional problems exist with regard to the boundary between Conversion Forest and degraded Production forest. Finally, there are problems with the definition of State Private Property; if an area is considered forest land, at what point is this deemed to have lost its public interest use, and hence reclassified from State Public to State Private land. This lack of clear definitions gives rise to major weaknesses in the forest and land classification system (IFSR 2004, Oberndorf 2006). Without clarity on these issues, insecurity will continue and leave the law open to manipulation by those who posses power and political connections.

Forest user rights and prohibitions

It is important to establish what forest user rights local communities are entitled to, and what are the rules they must abide by as defined in the Forestry Law. Over the years, local communities have adapted their lifestyles to their surrounding environment, and many livelihoods have been dependent on the forest resources for generations. The forest provides land for growing crops, establishing residences, and a multitude of NTFPs that are used for everyday sustenance and for generating income. While previous livelihood practices were considered the norm in the past, today they may be considered forest crime under the Forest Law. Future REDD activities may increase protection of the forest and further restrict locals' use. However, if livelihoods are excessively negatively affected, this will increase the amount of risk in achieving permanent emission reductions. Investors and carbon standards also require that local livelihoods are not compromised for the sake of emission reductions (CCBA 2005).

The rights and responsibilities of local communities are the following:

Community Rights: Local communities have customary user rights to collect Forest Products & By-products within the Permanent Forest Reserve. However, in the case of Protection Forest, the amount allowed to be collected will be more limited so that it will have minor impact on the forest health (Article 2). In general, locals may freely use the forest for traditional family use under the conditions that it is sustainable, not disrupting the natural balance of the forest ecosystem, and in respect of the rights of other users. Traditional user rights consist of:

- Collection of dead wood for cooking and heating purposes;
- Collection of wild fruit and resin and other forest by-products;
- Collection of grass cuttings or unleashing livestock to graze in the forest;
- The use of timber to build stables, fences or agricultural instruments;
- The use of timber from the forest to build residence - however you must check with FA officials to find out how much timber can be used; and
- You may barter or sell collected forest products as not as it is sustainable and does not cause significant damage to the forest.

Community Responsibilities: Although communities have legal customary user rights over these basic forest commodities, they also must adhere to certain rules. It is prohibited to:

- Process forest products or by-products at a commercial scale;
- Operate charcoal kilns within the Permanent Forest Reserve;
- Establish a new residence along a public or forest road in the Permanent Forest Reserve – this is considered illegal encroachment of forest lands;
- Set forest fires in Permanent Forest Reserve;
- Fell a tree without authorization;
- Possess a chainsaw or transport forest products and by-products without a permit; and
- Clear forestland and enclose it to claim ownership.

If any person(s) are in breach of the above forest crimes, they are subject to penalties defined by the forestry law.

5.5 Project area status

Based on the above analysis, it will now be explained how this relates specifically to the project area, and its immediate surroundings. The project area falls under the general jurisdiction of MAFF and the FA. Forested land within the project area is deemed to have a public interest use and is therefore classified as State Public Property under the Land Law and further classified as Permanent Forest Estate under the Forestry Law. Figure 5.2 shows the different boundary divisions and the jurisdictions of the surrounding areas. The vast majority of the land surrounding the project boundary is classified as Protected Area and under jurisdiction of the MOE. The Central Cardamoms to the north is classified as Protection Forest and is under the jurisdiction of the FA.

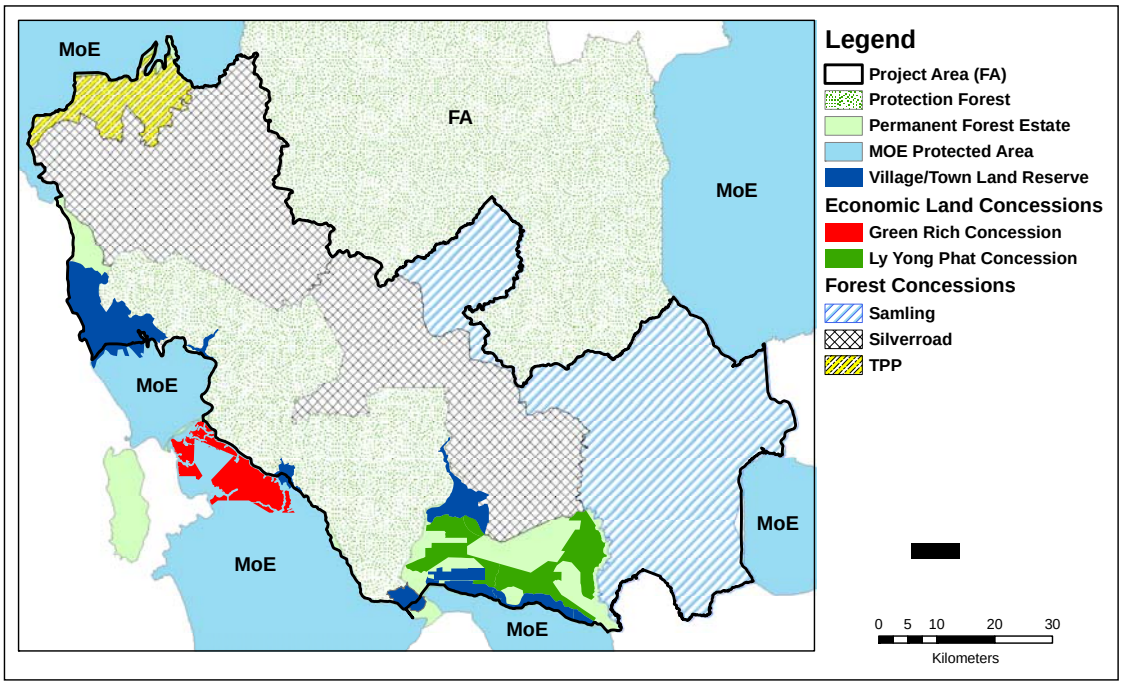


Figure 5.2 Forest classification, administration and concessions.

Since there is no privately owned forest within the project boundaries, all forested land is classified as Permanent Forest Reserve. Figure 5.2 outlines the different boundaries and compartments. Of the total project area (610,927 ha), approximately 145,000 hectares are classified as Protection Forest. There are three compartments assigned to logging concessionaires (currently under moratorium) amounting to approximately 400,700 hectares – this forest is classified as Production forest. The remaining forest land is considered either Conversion forest or Production forest. As all forest land within the project boundaries are Permanent Forest Reserve, i.e. State Public Property, this means that the state has ownership rights of the forest and the carbon that it contains.

Besides the different forest classifications, Figure 5.2 also shows two other types of land use; land granted as 1) economic land concessions, and land reserved for 2) local communities.

Economic land concessions

There are two economic land concessions depicted in Figure 5.2. The Ly Yong Phat concession is within the project boundary, amounting to 20,000 hectares. The Green Rich concession is in the Botum Sakor National Park and amounts to 10,000 hectares. The sheer size of these concessions means they have considerable influence on land use and land management in the area. However, these concessions have also had major social implications for locals, and are shrouded in illegal activities, and in violating the Land Law and the Sub-decree on Economic Land Concessions.

The Ly Yong Phat concession: In September 2006, two companies, both owned by the CPP senator Ly Yong Phat moved into the Chi Khor Leu Commune (located within the project area) and used military police to forcibly evict 250 families to establish 20,000 hectare sugarcane plantation. As the police moved in, villagers' crops and residences

were destroyed (Licadho 2008). The two companies – Koh Kong Plantation (9,400 ha) and Koh Kong Sugar (9,700 ha) – were manipulatively formed so that the law's limit on concession size (10,000 ha) could be circumvented. The rule that the same person could not own neighbouring concessions of this size was also ignored (Bristol 2007).

The Green Rich Group concession: In 1997 over 60,000 ha of MOE Protected Area forest, was granted as concession for acacia and oil palm plantations at various locations throughout Koh Kong province (WRM 2005). Since 2002, Wildlife Alliance has been struggling with authorities aiming to reduce the size of the concession to within the amount stipulated by the Land Law (10,000 ha). The same law specifies that economic land concessions can only be granted on State Private property. Clearly, the Protected Area falls under the category State Public property and therefore, in theory, should not be allocated to land concession.

Figure 5.3 Logs at the Green Rich concession.

Local communities

Wildlife Alliance has been working with the FA and local communities to define the boundaries between land reserved for community development and Permanent Forest Estate. So far they have demarcated villages in four communes, Koh Kong town and road 48 (Wildlife Alliance 2008). Although boundaries of villages have been defined, the land within has yet to be legally approved as village land by the RCG. Plans for approval are in development. This land will likely fall within the category "Collective Ownership" under the Land Law. There remain many villages to be demarcated but work on this is ongoing. If the boundaries of village land need to be expanded in the future, this could operate through the Social Land Concession system. However, limited availability of State Private land nearby villages, on which social land concessions can be granted, may result in unanticipated clearing of forest land. With regard to forest user rights and prohibitions, local communities must abide by the Forestry Law described in the previous section. The area designated as Protection Forest is subject to tighter restrictions on user rights.

5.6 Summary

The existing institutional set-up provides a solid platform upon which the REDD project can be developed. National policy is supportive of the REDD concept and the laws and regulations governing forests, land management and ownership provide the fundamental building blocks for REDD development. Despite this, there are several priority areas that need substantial improvements for overall project success and risk minimisation. The issue of insecure property rights is one point of major concern. The lack of transparency and consistency in land concession system also needs attention. With regard to the basic institutional and legal arrangements for the REDD project the RGC are identified as the owner of the forest carbon with the FA acting as the seller. Early indications have shown that the RGC are willing to commit to recycling benefits back to the communities development, which is essential to the long-term success of the project.

6. Socio-economic assessment

The majority of rural communities in developing countries are highly dependent on forest resources and the natural services that forest provides. The forest can supply a secure source of livelihood for many households and offers alternatives to cope with risk in time of hardship. A strict forest policy might on one hand protect the forest from degradation, but on the other, may destroy an important element of local livelihood.

When a REDD project is developed to preserve forest carbon, it is therefore necessary to consider the locals' utility of the forest, so the project can ensure equity and social well-being as well as an actual emission reduction. In the Southern Cardamom Ecosystem, there has been increasing enforcement of the Forestry Law since Wildlife Alliance started its work in 2002, restricting local people's use of forest. Law enforcement alone may provide a short-term fix to forest degradation, but in the long run a more sustainable, integrated approach is needed. For the carbon project to be successful it is therefore important to address how the local people are affected, if they are in need of any type of compensation in return for the restricted forest use, and if it is possible to further increase restriction levels.

In this chapter, the result of a household survey on local dependency and forest use conducted in the Southern Cardamom Ecosystem will be described and analysed. In the first section a short introduction will be given to the survey and the methodology used. This will be followed by a section on the livelihood and the forest dependency of local people. Finally, the chapter will conclude with a *Willingness to Accept* estimation, which aims to highlight the willingness of local people in the Southern Cardamom Ecosystem to accept additional restrictions of the forest use.

6.1 Set-up of household survey

The household survey was constructed with the objective of identifying the forest dependency of local people in the Southern Cardamom Ecosystem, as well as uncovering some of their perceptions and establishing their socio-economic characteristics (see the questionnaire in Appendix V). The survey was divided into four sections with a total of 26 questions. Section 1, Household characteristics, was focused on the size of household, educational level, migration information and the composition of the household's livelihood. In section 2, Usage & Dependency of forest, the importance of forest for the livelihood of the household was addressed. Section 3, Awareness, addressed observed changes in the state of the forest, and finally, in section 4, Compensating Measures, the willingness to accept a restricted forest use and possible compensating measures were addressed.

Before the survey was carried out, it was corrected and translated with the help of Wildlife Alliance and staff from the Forestry Administration. The survey was tested in the area around Chi Phat over two days and was readjusted after having conducted 20 test surveys.

The survey was carried out in the period from 17th of May to 5th of June 2008, with a total of 436 respondents. The goal was to interview a part of the predominantly rural population in the Southern Cardamoms who are likely to be dependent on natural resources and possibly could be affected by the restricted forest use. With the help of local experts, the main resource dependent communities were identified in the Southern Cardamom Ecosystem. Taking into account the rainy season and limited timeframe and resources, 5 out of the 9 districts in the area, covering 25 villages, were visited.

Figure 6.1 shows the villages that have been surveyed and their relating communes. Further information on the villages, the estimated number of households, as well as the distribution of interviewed households can be found in Appendix IV.

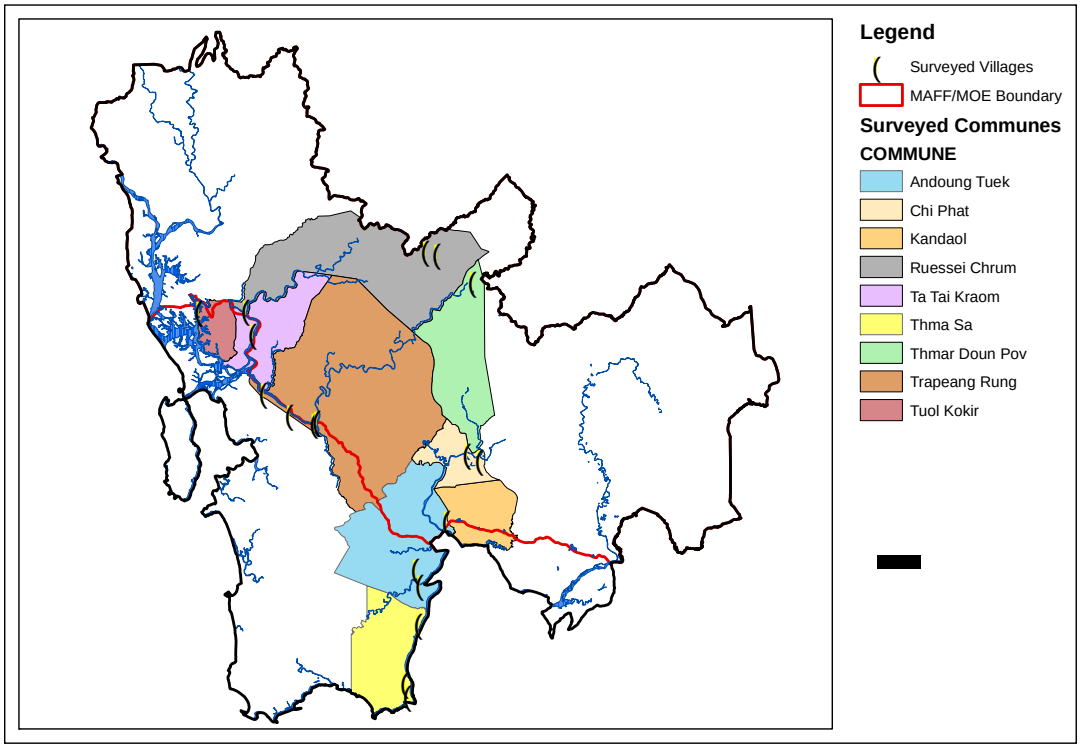


Figure 6.1 The survey area with the interviewed villages and commune boundaries.

Considering that the main villages in the Southern Cardamom Ecosystem have been interviewed, covering villages in South and North, as well as in coastal and inland areas, the surveyed area is likely to be representative for the Cardamoms as a whole. However, due to limited studies and dated information it has not been possible to verify its representativeness.

Six interviewers were selected to conduct the survey, four students and two members from the Forestry Administration. The survey was conducted face-to-face, with an adult family member interviewed in each selected household. The average duration of an interview was 30 minutes.

Parallel to the survey, several key informant interviews were conducted to get a thorough understanding of the local's livelihood, their forest dependency as well as to probe more deeply into survey responses. These interviews with locals were complimented by several semi-structured interviews with village chiefs and commune leaders upon arrival

to each new village. This gave us a good overview of the area, the livelihood of people living there, and assisted us in estimating the number of households and how we could reach them.

In the following, the result of the survey analysis will be presented. Each section will end with a short description of the regional differences within the project area. Significant differences exist between areas: the commune level proved to be the most appropriate to highlight these differences. As can be seen in

Figure 6.1 above, the communes interviewed included Thma Sa and Andoung Touk commune to the South (the MoE area), and Kandaol, Chi Phat, Trapeang Rung, Ta Tai Kraom, Tuol Kokir, Russei Chrum and Thma Doun Pov in the North (the MAFF area). The differences between communes have been calculated with the use of cross tab/chi-square and ANOVA statistical test (results can be seen in Appendix VIII).[17]

6.2 Livelihood and dependency on forest

The Southern Cardamoms is one of the least populated areas in Cambodia. With a total of 210,436 people[18] (Koh Kong Province in 2006), there is an average population density of 19 persons per km^2, which compared to the national average population density of 82 per km^2 is very low (Cambodia Atlas 2006). Most people living in the area are Cambodians, but there are ethnic minorities of Samre (indigenous people), Thai and Vietnamese (Asian Development Bank 2005). In general, people live in dispersed villages in houses built of natural materials, primarily wood, and with an average household size of 5 people.

The welfare in the region has been assessed through the indicators education, literacy and income. In the majority of households, primary school is the highest level of education, which is followed by secondary school and no education. Due to the absence of schools in earlier times and due to the fact that a high percentage never finishes their education, 42 % of the population above the age of 15 are illiterate. Compared to the average illiteracy level of Cambodia of 30 %, this is a quite high number (Cambodia Atlas 2006). Today, almost 95 % of children between the age of 6 and 15 attend school.

The monthly income of a household varies significantly between households. The average monthly income for a household is US$ 78 and the median is US$ 50. Figure 6.2 show the income distribution. Although income can be a useful measure for the poverty level, the fact that a large fraction of a household's production is for self-consumption, monetary income as such can be misleading. Cambodia Atlas (2006) has assessed the poverty level by an alternative approach: a comparison of the monetary value of goods and services that a person consumes. It was found that of all the provinces in Cambodia, Koh Kong province is the region with the lowest average poverty rate.

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[17] Some of the communes have a very low number of respondents (Thma Doun Pov, Tuol Kokir and Kandaol, between 13 and 20). The result for each of these communes will therefore often be influenced by the variation within the sample and there will rarely be seen significant results.

[18] The population is based on a projection from 1998 by NIS (2000). The last full count of the Cambodian population was in 1998, a new is scheduled for 2008.

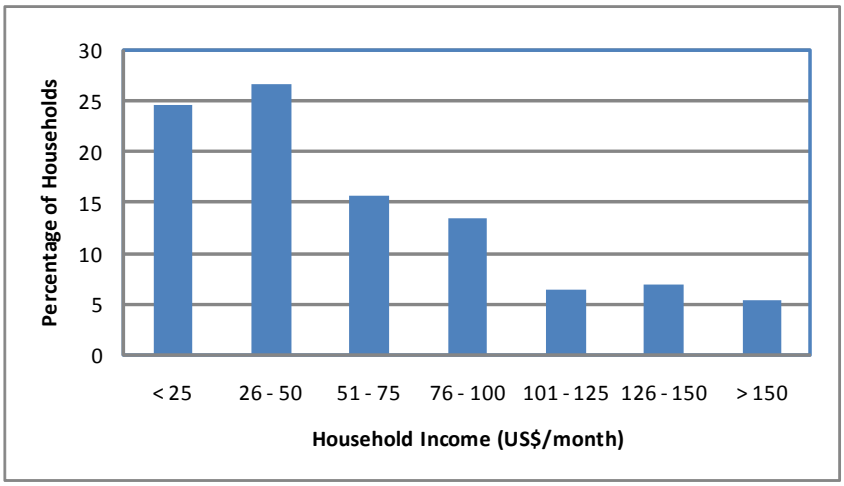


Figure 6.2 Income distribution in percent of households.

There are significant socio-economic differences between the communes in the Southern Cardamoms. The commune of Andoung Touk has a significantly higher percentage of illiterates and households with no education. This commune also has one of the lowest income levels. In contrast, Trapeang Rung commune, where a high illiteracy level also is present, is the commune with the highest income level. Together with a high variance, this shows a large variation in welfare within this commune.

The relatively high welfare in the region has attracted large numbers of immigrants. Of the current population, 39 percent originate from areas outside Koh Kong Province (see Appendix VI for the descriptive statistics). The area that was once remote and isolated has during the last 10-15 years, experienced high influx of people seeking an improved livelihood. It is primarily in the 1990's that people have moved to the area. The population in the province declined significantly during the Pol Pot regime (from 70,000 to 10,000). However since the fall of the regime, the population has increased steadily. This is largely due to the province having a reputation as an area with high availability of land and as a good place to earn a living by fishing or cutting timber.

> *"Now the province has 90,000 people and that is increasing every year as families encourage their relatives to come here, some to grow rice and fish but more to trade or cut timber," (Fitzgerald 1996).*

Migration to the Southern Cardamoms has increased the pressure on the diverse natural resources, with charcoal production and logging spreading uncontrollably into the protected forest and mangroves (Fitzgerald 1996). The culture of indigenous people is slowly being displaced by a high influx of lowland Khmer, Cambodians from the eastern regions. Migration to the area is likely to continue into the near future. According to the National Institute of Statistics (2000), the province of Koh Kong will experience the highest population growth in the whole of Cambodia, with an annual average population growth of 3.7 percent expected from 2006 to 2021. Such a population growth is likely to further boost deforestation, degradation of land, and depletion of water resources.

Immigration has mainly occurred in the remote mountainous area of Russei Chrum where more than 60 percent of the population are immigrants. Chi Phat commune also has a high immigration but has primarily experienced this during the period shortly after

1979, where people resettled after the fall of the Pol Pot regime. Today the commune has the lowest immigration rate. In contrast, Russei Chrum has experienced increasing immigration through the years and is by far the commune with the highest immigration in the period after 2000.

Occupation

Traditionally, people in the Southern Cardamoms depend on the natural resources supplied by the ecosystem. Most have been subsistence farmers surviving from chamka (swidden agriculture), where a piece of forest is cleared and cultivated for 2-5 years before the soil becomes nutrient-deprived. Hereafter, the land is left for re-growth and a new piece of forest or re-growth will be cleared for future cultivation. Other practices, such as fishing, hunting, logging, and non-timber-forest-products (NTFP), have also contributed to local livelihood. Timber and NTFPs, have not only been important in situations of food shortage, but have played an intrinsic role in the livelihood of many rural households (Asian Development Bank 2005).

Figure 6.3 presents the importance of different livelihood practices on a scale from 1 to 5. Growing crops is for 91 % of the households, the most important source of livelihood. Rain fed rice cultivation is the most prevailing crop production, but the yields are relatively low due to poor fertility of the soil (Cambodia Atlas 2006). In contrast to other regions of Cambodia, most people in the area only grow rice in the wet season (Agrifood Consulting International 2005). The low yield and dependency on rain fed rice cultivation, makes Koh Kong the province in Cambodia with the second highest rice deficit. Since rice is the most important food stable, a rice deficit contributes to food insecurity and increases dependency on alternative livelihood sources in the months where there is no rice (World Food Programme 2008).

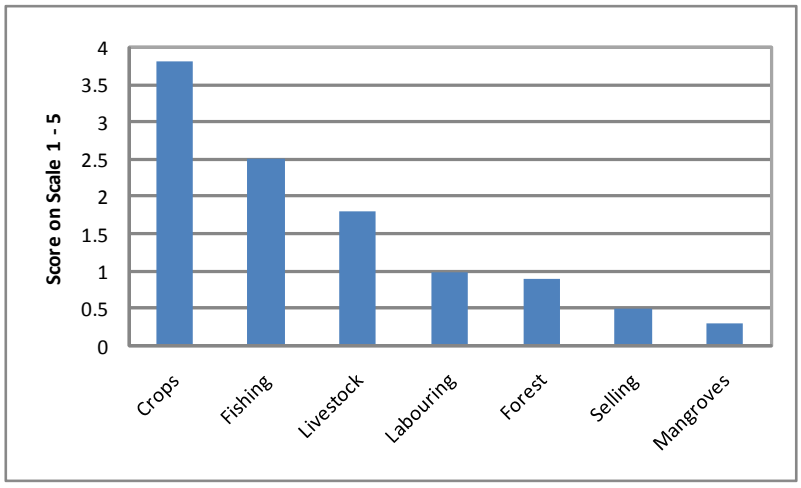


Figure 6.3 Importance of livelihood practices on a scale from 1-5.

Even though rice is the most important crop, there is a myriad of other crops grown in the region, including maize, cassava, sweet potato, vegetables, and sugarcane. Due to the low infertility of soil, the yields of all crops in the region are generally lower than the national average, with the exception of sugarcane (Agrifood Consulting International 2005). Several fruit species such as banana, cashew, jackfruit and pineapple, are also

grown. Typically, the survey shows that people dependent[19] on crops have a significant lower income than those that are not dependent.

Figure 6.4 Preparing the soil for rice, Chi Phat.

Figure 6.5 Sowing rice by hand, Chi Phat.

Fishing is the second most important practice after farming. Fishing communities are primarily living along the coast, but for many villages located along riverbanks, fishing also constitutes an important part of their livelihood. Fish, after rice, is the second most important source of food. Fishing contributes to the households' own consumption, as well as to monetary income. Even though fish is important for the livelihood of local people, in general, the living standards of fishing communities has been declining over the last few decades. An important reason for this decline is the overexploitation of fish stocks (Cambodia Atlas 2006).

Besides the natural based livelihood practices mentioned above, around one fifth of the households depend on the non-natural based livelihood practice. 23 percent of the households earn an income as labourers and 12 percent of households are involved in trade. People that are dependent on labouring and trade generally have a lower dependency on natural resources, and particularly households doing labour was found to have a significant higher income than households with more natural based livelihoods.

Significant regional differences are present between the communes in relation to occupancy (see Appendix VIII, table 1). The inland communes of Chi Phat, Russei Chrum, Thma Doun Pov and Ta Tai Kraom have significant higher dependency on crops. Only two communes do not have crops as the most important livelihood practice: in Thma Sa and Trapeang Rung fishing is the primary livelihood source.

Forest & mangrove resources

Approximately 21 percent of households are dependent on forest resources, while only 7 percent are dependent on mangroves. Forest is thereby the fifth most important livelihood source as can be seen in table 6-1. We had expected a higher percentage of local people to be dependent on the use of forest. However, the restricted forest use during the last five years, as well as the illegalisation of collecting forest products for commercial purpose may have made people apprehensive about revealing their true level of usage of the forest.

[19] A household has been categorised as *dependent* on a livelihood practice, if the household find it important and/or very important for their livelihood

Even though only around one fifth of the population is directly dependent on forest, 72 percent are collecting products from the forest. The most frequently used forest product is firewood; a total of 55 percent of the population are collecting firewood from the forest (see Figure 6.14). From a countrywide survey in 2004, it was found that 84 percent of Cambodians rely on firewood for cooking and 5.5 percent rely on charcoal (Cambodia Atlas 2006). The number found in our survey area shows that around 70 percent of the population collect firewood and charcoal in the forest, with the remainder getting it through alternative sources including the local market, household gardens and from the surrounding degraded land.

Besides firewood and charcoal, other frequently collected forest products include Fruits and Vegetables, Rubber and Rattan. Only 1.4 percent collects timber for construction, which is surprising when taking into account that almost all houses are built of wood. Timber extraction is one of the products that through the law have become restricted, and permission from the FA is needed to extract timber from the forest. Several locals mentioned that they were in need of timber, so either they are honestly not using timber due to the authoritarian system or they are apprehensive about revealing their true usage.

The collected forest products are mainly used for own consumption (66%). However, this number covers a large variance between the different products (Figure 6.6).

While firewood, charcoal, fruits/vegetables, spices and medicine mainly are collected for own consumption, resin, rubber and rattan are mainly sold. Wild meat is the only product having its highest share in *Mix of both* (i.e. own consumption and sale). The products used for selling are mainly collected during the dry season when the forest is more accessible and substitute income when there are no crop yields.

People very dependent on forest resources are characterised by having a significant lower income than people not dependent on forest. Most often these people are also highly dependent on crops, so in general, people having a high dependency on natural resources are among the poorest in the society.

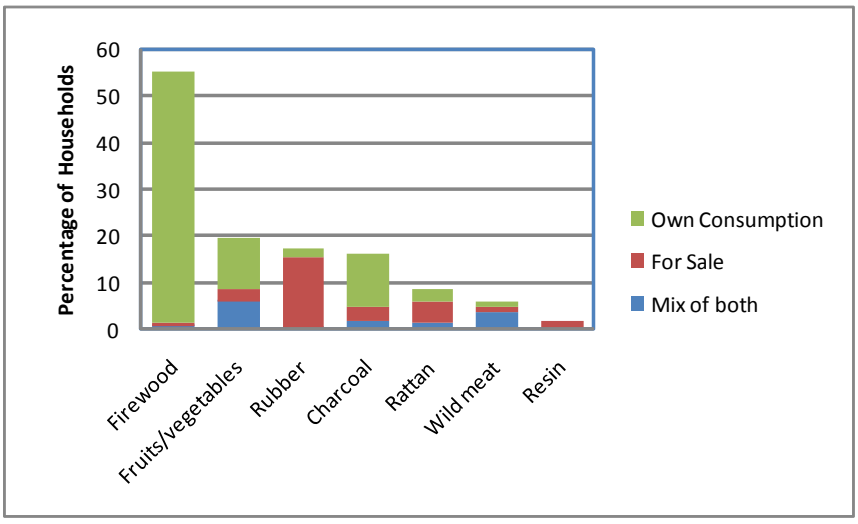


Figure 6.6 The percentage of households collecting forest products (only the main products are included) and the percentage that is used for own consumption, for sale and for both own consumption and sale.

In relation to the regional differences, forest resources constitute a more significant part of the livelihood of people living in Chi Phat and Ta Tai Kraom (see Appendix VIII, table 1 and 2). In Chi Phat commune, forest resources is actually the third most important livelihood practice, which corresponds to a lower income level in the commune. What is common between the two communes is that a high percentage of households collect the forest products that mainly are sold, such as rubber, rattan and wild meat. In Ta Tai Kraom as much as 33 percent of the households are collecting forest products for selling.

Drivers of deforestation & insecure land tenure

Most local people have been living adjacent to the forest for several years, and therefore have firsthand experience of the drivers of deforestation. In Figure 6.7, the local people's perception of main drivers of deforestation can be seen on a scale from 1 to 5. Small-scale agriculture is clearly seen as the main reason for deforestation by respondents, which is followed by land encroachment and firewood.

The two main drivers of deforestation, small-scale agriculture and land encroachment, are deforestation drivers caused by the demand for land and not on forest products. This emphasises the situation that is prevailing in most of Cambodia: insecure land titles, rising land prices and a corresponding high level of encroachment on forest.

The high availability of accessible land in the Southern Cardamoms, together with insecure land tenure, has attracted land speculators, businessmen and immigration to the Southern Cardamoms. All have contributed to a growing pressure on the forest resources. Insecure land tenure not only contributes to deforestation directly but also indirectly; if local people have their land taken away, they may be forced into the forest to clear a new piece of land. This type of land conflict occurred in 2006 when a sugar plantation concession was granted in Kandaol commune on local peoples land (see further in section 5.5).

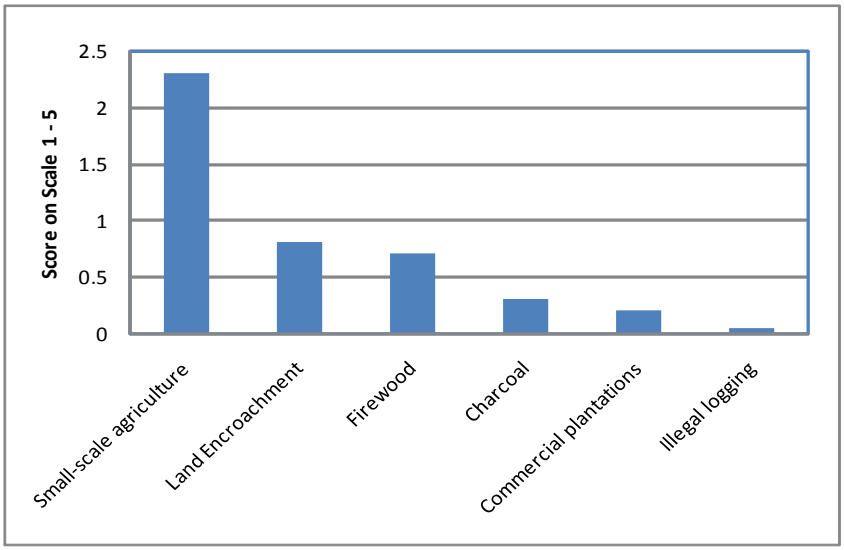


Figure 6.7 Average score for the main drivers of deforestation on a scale from 1 to 5.

At the current state, 50 percent of households in the Southern Cardamoms do not have a land title. Most likely this number is even higher. In some cases village chiefs and com-

mune leaders issue "fake" land titles, which result in people thinking they own the land. In other cases people think they own the land because they have been living and using the land for many years. But often they do not have a concrete paper with land title, which can work against them in the situation of a land conflict.

The importance of solving the land tenure issues is shown by the fact that 89 % share the opinion that clearly defined land titles would reduce deforestation (Figure 6-10). This again highlights the importance of securing property rights, not only for the livelihood of local people, but also for the forest.

Significant differences are present between the communes on perceived drivers of deforestation (see Appendix VIII, table 3). In the Southern communes administered by the MOE (Thma Sa and Andoung Touk), land encroachment and small-scale agriculture have significantly higher scores as the main drivers of deforestation. This is closely related to the status of land tenure; approximately 80 percent of households in the MOE area have no land title and the area is characterized by weak law enforcement. In Kandaol commune, the granting of the sugar plantation in 2006, coupled with the fact that more than 70 percent do not have a land title, relates to commercial plantations having the highest score as main driver of deforestation. Finally, the remote commune of Thma Doun Pov seems to have a relatively high proportion reporting firewood and charcoal production as the main drivers. This could be due to the fact that no Wildlife Alliance ranger stations are situated close by.

The effect of strict forest policy

Legal restrictions have had a major impact on local people dependent on collecting products from the forest and on practicing chamka. The restrictions have clearly affected the level of deforestation as was shown in the *Technical Assessment.* However, due to different style of administration in the North and in the South of the Southern Cardamoms (MAFF and MOE respectively), different restriction levels have been enforced in the two areas. This section will therefore focus on the difference between the MOE and the MAFF area.

In relation to the magnitude of deforestation and degradation, in the MOE area 90 percent of households have experienced deforestation and degradation of the forest during the last 5 years, while only 57 percent have experienced it in the MAFF area (Figure 6.8).

A similar contrast can be seen between the two areas when comparing the percentage of households clearing land (Figure 6.9). Around 20 percent of all households have cleared a piece of forest/mangroves during the last five years. However the percentage of households clearing land is significantly higher in the MOE area. While the percentage clearing land in the MOE area has been almost constant through the last five years, it has decreased from 7 percent/year in 2003 to 1 percent/year in 2008 in the MAFF area. Most of the clearings in the MAFF area happened before 2003, which was the year stricter law enforcement were introduced in the MAFF area.

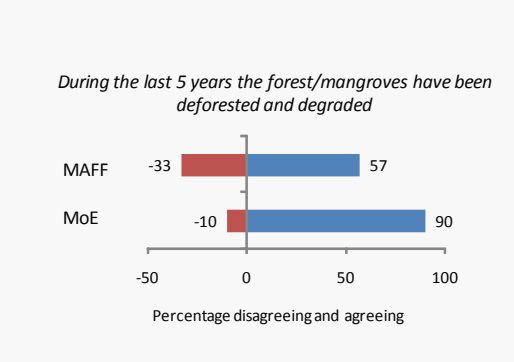


Figure 6.8 Statement on deforestation.

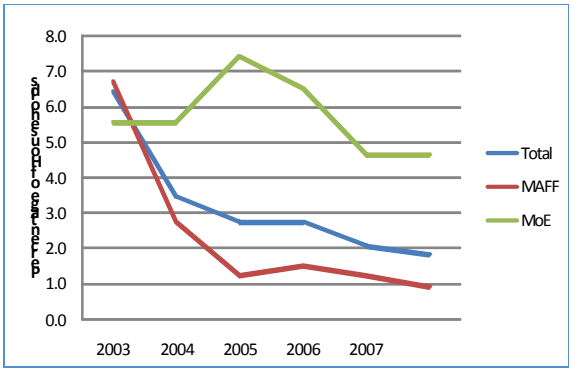


Figure 6.9 Percentage of households that have cleared a patch of forest within the last 5 years.

When local people clear land, they do it out of necessity, because they are poor and because they need to sustain their livelihood. More specific reasons for people to clear land are:

- The need for agricultural land for an increasing population;
- Generating an income by clearing land for businessmen (land grabbers/speculators)
- Low infertility of formerly cultivated land

The fact that clearing land is a survival strategy is also shown by the fact that it is mainly the poorest fraction of the population that are clearing land (on a 0.10 significance level), together with households that are dependent on forest resources (see Appendix VII for the statistical test). Even though people are aware that the forest is protected and that it is illegal to cut trees in protected forest, the living standards are so low that protecting the forest is not a high priority compared to sustaining their livelihood.

Therefore, the restricted forest use has primarily affected the poorer natural resource dependent communities. More than half of the population feel that the forest restriction has affected their livelihood negatively (see Figure 6.10). The people that feel that their use of forest has become restricted are significantly related to the people that are dependent on forest resources and/or crops.

In line with two thirds of the population being negatively affected by the forest restrictions, many locals feel unfairly treated by the law and share mistrust towards the government and Wildlife Alliance. Several villagers expressed frustration by the fact the there is no law stopping businessmen from clearing forest while local people are punished for it, echoing the harsh reality of elitism and unfair treatment of the poor. Another factor contributing to frustration is the blurred distinction between collecting forest products for own consumption (which is legal) and for commercial (illegal).

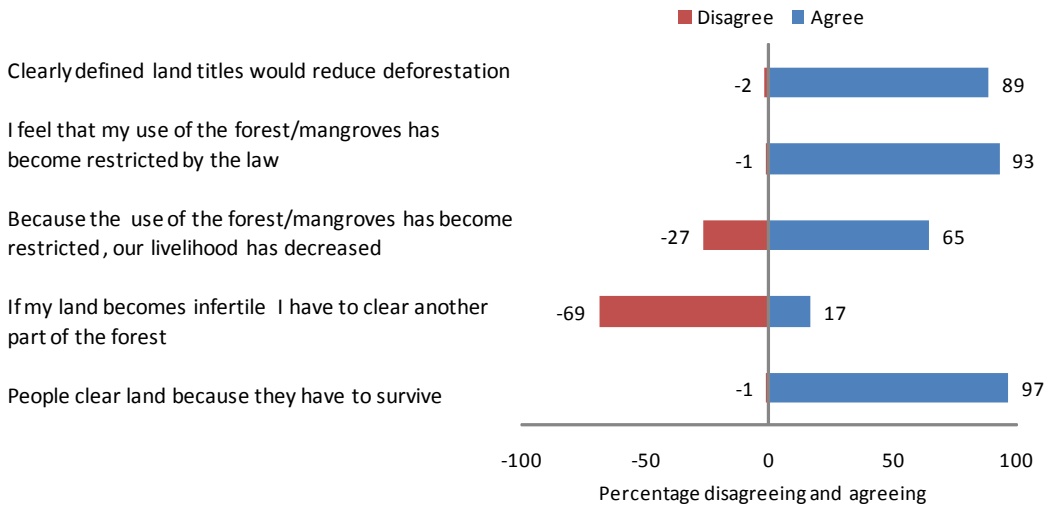


Figure 6.10 Statements on forest restrictions.

Through interviews with Wildlife Alliance, FA and rangers, it was found that there are no clear guidelines of what quantities of timber and NTFPs can be legally collected. The judgement is based on the qualitative interpretations of the collected forest products whether they are for commercial purpose or for domestic use. However, no exact quantities are defined or documented. This is a very important aspect that should be addressed so that local people have something to gauge from (i.e. how many kilos or items of a product are they allowed to collect and how often).

During a key informant interview in Trapeang Rung commune the woman of a house explained how she had been collecting forest products for the household's domestic usage, but had been arrested by a patrol and received a fine of US$ 2000 standing accused that they were collected for a commercial purpose. When discussing the story with Wildlife Alliance, it was explained that she must have collected a very large amount of products and that it therefore, must have been collected for commercial purpose. No matter what the true story is, it emphasizes the problem by not having clearly defined borders of what quantities of forest products are allowed to be collected and what are not.

Figure 6.11 A piece of forest has been cleared and banana trees have been planted, Russei Chrum.

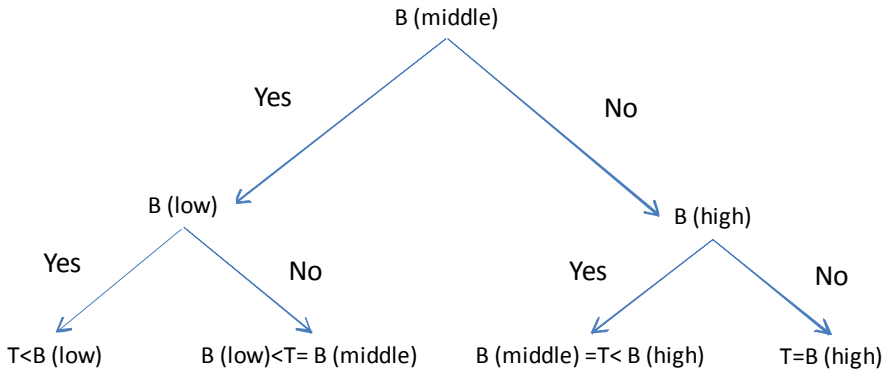
Figure 6.12 Confiscated timber outside ranger station in Trapeang Rung.

6.3 Willingness to accept a restricted forest use

The earlier sections revealed the socio-economic situation of local people as well as their dependency on forest. In this section the result of the willingness to accept valuation will be presented. The section has two aims; 1) to reveal the value of the forest local people attach to it[20], and 2) to reveal if local people are in need of any type of compensation for the restricted forest use, and if so, what type of compensation is most needed.

Methodology

Willingness to accept is a contingent valuation method. In contingent valuation people are asked to state a value on a specified change in environmental quality, in this case the value that they are willing to accept for a restricted use of forest. The willingness to accept, was addressed through two questions; a close ended and an open ended question. The close-ended questions were asked using the double-dichotomous, discrete choice method, as illustrated in Figure 6.13.Using this method, the respondent is asked if he/she would accept a first start bid (B (middle)) to completely stop clearing forest or cutting timber. If the answer is *Yes*, the respondent is asked if he/she would accept a lower amount (B (low)). If the answer to the start bid is *No*, then the respondent would be asked if he/she would then accept a higher amount (B (high)). In this way the respondent can be classified into one of four categories, see Figure 6.13.



Source: modified after figure 1 in Hadker *et al.* 1996.

Figure 6.13 Illustration of the double-dichotomous, discrete choice method. T is indicating the respondent True Willingness to accept.

Based on the survey testing, five start bid categories were chosen, with a variance of 50 percent around each start bid.

The five categories were administered randomly, but with an even distribution in each village and for each interviewer. The closed ended question was supplemented by an open ended, where the respondent was asked to identify his minimum willingness to stop clearing forest and extracting live wood. Due to the fact that the respondent already has been presented a monetary value in the start bid, he/she was most likely affected by this, which opens up the problem of *starting point bias*.

[20] The value equals the opportunity costs for conserving the forest of local people

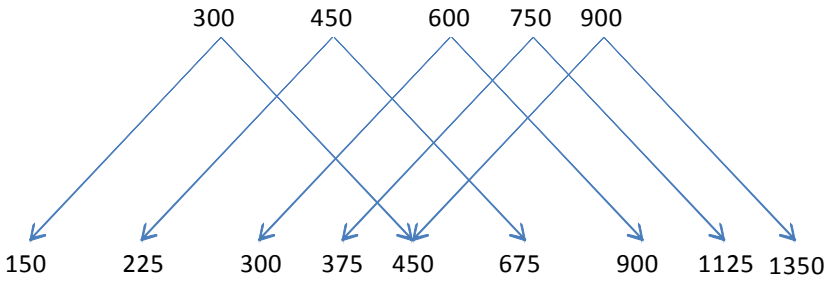


Figure 6.14 The five start bid categories with corresponding second bids (B(low) and B(high)).Values are given in US$/year.

To reveal which characteristics of the respondent have an influence on the WTA, a linear regression analysis was conducted. The influencing variables can be derived from the linear regression function:

$$WTA = \sum x_i \cdot \beta_{xi} + \varepsilon_{xi}$$

where the WTA is equal to the sum of the i variables (x) multiplied by the coefficient β of the relation between WTA and the i^{th} variable, and the corresponding error constant ε. If a variable has influence on the WTA the coefficient will be different from 0. Therefore, the following hypotheses are set up:

$$H_0 : \begin{pmatrix} \beta_{x1} \\ \beta_{x2} \\ \dots \\ \beta_{x\infty} \end{pmatrix} = 0 \qquad H_a : \begin{pmatrix} \beta_{x1} \\ \beta_{x2} \\ \dots \\ \beta_{x\infty} \end{pmatrix} \neq 0$$

The null hypothesis states that there is no correlation between any of the i variables and WTA (the coefficient β = 0), while the alternative hypothesis states that at least one of the i variables has a coefficient different from 0.

In this report, only the open-ended willingness to accept question will be analysed. Further research is currently being conducted on the close-ended question and will be presented at a later stage.

Results

The willingness for a household to accept a restricted use of forest ranges from 100 to 2000 US $ per year. The dataset has a considerably high variance with an average of 656 US$ per year and a median of 600 US$ per year. Several variables were assumed to have an influence on WTA, such as degree of forest dependency, crop dependency, income, if forest restrictions has affected livelihood and so on. All variables were checked for multi-collinearity before the analysis was conducted.

The analysis resulted in the linear model presented in Table 6.1 and Table 6.2. The modelled function has an R^2 of 0.288 and thereby explains 28.8 percent of the variation in WTA. The function is made up of the variables: start bid, importance of forest, importance of selling, number in household and agricultural machine as the preferred type of

compensation for a restricted forest use[21]. The most influential variable is the start bid that accounts for 17 percent of the variation in WTA. Forest dependency explains 4.7 percent, and the remaining variables all contribute with additional 2 percent. The result is significant, and the null-hypothesis can thereby be rejected.

Table 6.1 Coefficients and significance level of the best-fitted model.

	Unstandardized coefficients		Standardized coefficients	t	Sig.
	B	Std. Error	Beta	B	Std. Error
(Constant)	166.14	66.72		2.49	0.013
Start bid	0.52	0.08	0.38	6.74	0.000
Forest Dependency	31.94	10.56	0.17	3.02	0.003
Selling Dependency	-38.97	13.39	-0.17	-2.91	0.004
No. in household	22.42	7.90	0.16	2.84	0.005
Agr. machine as compensation	87.95	33.35	0.15	2.64	0.009

Table 6.2 Model summary and predictors.

Model	R	R square	Adjusted R square	Std. error of the estimate	Predictors
1	0.42	0.17	0.17	262.29	(Constant), Start bid
2	0.47	0.22	0.21	255.24	(Constant), start bid, forest dependency
3	0.49	0.24	0.23	252.30	(Constant), start bid, forest dependency, selling dependency
4	0.52	0.27	0.25	248.88	(Constant), start bid, forest dependency, selling dependency, No. in household
5	0.54	0.29	0.27	245.70	(Constant), start bid, forest dependency, selling dependency, No. in household, agr. machine as compensation

If the start bid is excluded from the analysis, the modelled function only accounts for 14 percent of the variation in WTA. Even though the start bid has an unusually high influence on the WTA, it was found that the WTA is significantly related to the degree of forest dependency. People dependent on forest resources have a higher WTA and when the importance of forest increases with 1[22] the WTA increases with 31.9 US$.

The three remaining influencing variables are: dependency on trade (selling), number of household members, and agricultural machine as preferred compensation. Together they explain 6.5 percent of the variation in WTA. The result is emphasising the importance of having an income to release the pressures felt by restricted forest use. The results also

[21] All respondents were asked what type of compensation they preferred for a restricted use of forest. See the following section, *Compensation*, for more information

[22] Increase by 1 on the scale from 1-5 presented earlier in the chapter.

indicate that a larger family means that more people have to share a limited amount of resources, therefore forest resources may be a more significant asset for the livelihood of these larger households. Finally, it also shows that people preferring an agricultural machine as compensation for the restricted forest use have a higher WTA, most likely because of the needed investment.

The significant start bid bias demands a more thorough discussion. Above, it was found that start bid accounts for 17 % of the variation in WTA. Is the average stated WTA calculated for each start bid, the result is even more noteworthy (Figure 6.15). The observed average of WTA in relation to start bid has an almost perfect fit of the linear function, y=0.5159x + 346.07. The good fit means that with 1 US$ increase in start bid, the average WTA within each group increases with 0.52 US$ which is an unusual high influence of start bid.

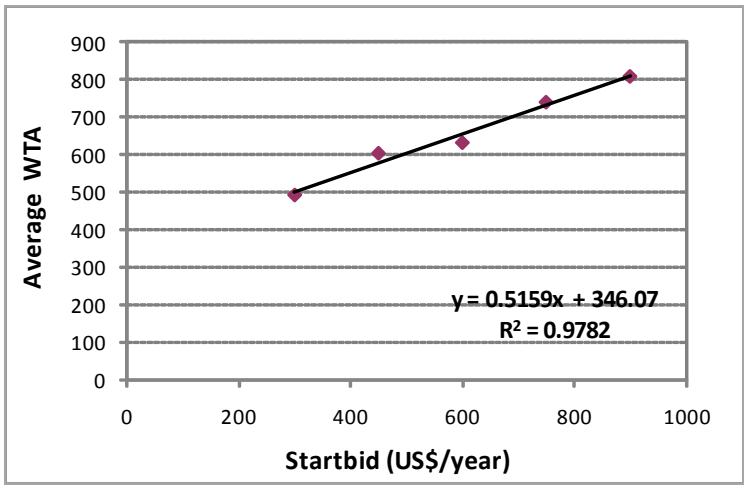


Figure 6.15 The relationship between the five start bids and the corresponding average of willingness to accept.

A high variance within each group, some have low WTA and some consistently state a WTA several percentages higher than the start bid, outweighs each other, and result in an average that is related to the start bid. Even though this figure, does not say much about the individual household's WTA, it indicates a serious instrument bias. The bias could be a consequence of several factors present in the ecosystem. Local people had difficulties understanding that their WTA should express the value they hold of the forest resources and not simply be an expression of what they need because they are poor.

The value of the forest for local people is difficult to estimate due to the influence of start bid. There is however, a significant higher WTA for households being dependent on forest, having many family members and preferring an agricultural machine. This difference indicates that some households are and will be negatively affected by the forest restrictions.

Analysing the characteristic of the people that reject the start bid can help to give a better indication of the willingness to accept a restricted forest use. The percentage of accepted start bids can be seen in Figure 6.16.

The percentage of people accepting the start bid is increasing until a start bid of 600 US$/year, where after it becomes approximately constant with around 20 percent of

respondents rejecting it. There is a significant higher percentage of forest dependent that reject the start bid. The average WTA of forest dependent people is around US$750 per year and seems quite high compared to the average income of US$656 a year. However, a high proportion of forest resources are used for domestic purpose, and the value of these is therefore not included in the income. The high WTA could also be an indication of forest products being an important source of income. According to Cambodia Atlas (2006) a household collecting forest product can gain between US$280 and US$345 per year. The high inflation during the last year could have easily increased this number further. The importance of forest products as an income-generating asset is further emphasised by the fact that people *selling* collected forest products are found to have a significantly higher WTA than people collecting for domestic use.

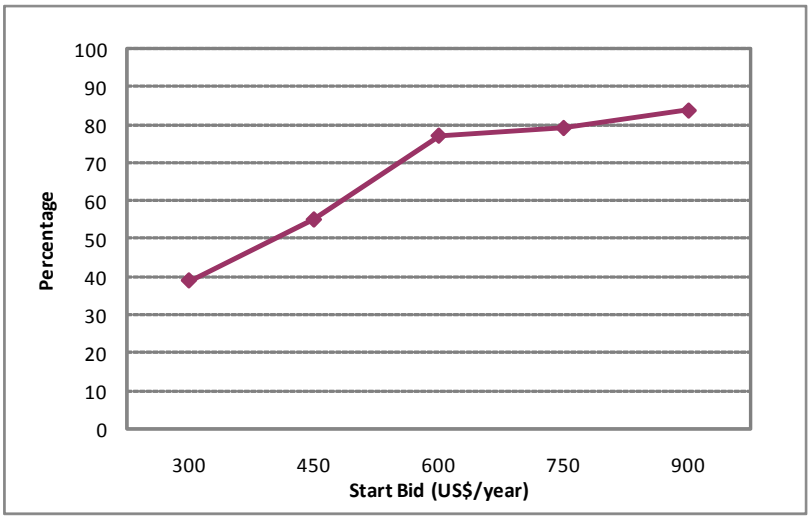


Figure 6.16 Percentage of respondents accepting the start bid.

But how can it be explained that several people not dependent on forest resources, or having large households have high WTA as well?

- *Restricted access to agricultural land:* One villager mentioned how the forest restrictions have kept him from clearing land and his WTA of 1100 US$ was therefore an expression of what a piece of land would cost to buy. This seems reasonably with the current agricultural land price of US$ 4,000 per hectare in Koh Kong province (Angkor Real Estate 2008).
- *Disbelief in support from government and NGO's:* Disbelief in the government and in support from organisations in general, could have made local people state a very high monetary amount, hoping that they would receive the amount at least once. Thereby, the WTA could be an indication of a one-off amount and not the yearly payment asked.
- *Substantial illegal forest activities:* High WTA could also be an indication of substantial illegal forest activities happening in the survey area that are not revealed through the survey. The area was suspect to a high degree of illegal activities before Wildlife Alliance started patrolling, and some of these activities are most likely still occurring.

- *Protest against the strict law enforcement:* Finally, a high WTA could be an indication of protest against the system of restrictions that has been present in the region for the last five years. This resistance against restrictions is emphasised through the recent demonstration against Wildlife Alliance in several villages throughout the survey area. Furthermore, a villager in Chi Phat told us how he had been working with community development in Wildlife Alliance but had to stop because the other villagers began to distance him from the community.

Even though the WTA is significantly influenced by start bid, the analysis shows that local people are affected by forest use restrictions. Continuing to restrict the locals forest use as is done now, should therefore be considered to be complimented by some form of compensation.

Compensation measures

To minimise risk of a REDD project, compensating people for a restricted forest use can play an important role. In Figure 6.17, the preferred type of compensation by local people is shown on a scale from 1 to 5.

Land is the most desired type of compensation, followed by cash and agricultural machine. However, considerable differences exist between the communes (see Appendix VIII, Table 4). Six out of the nine communes rank land as the preferred compensation. Characteristic for these communes is that most of them have either a high degree of people without land title, have a high population density or has experienced a high level of influx.

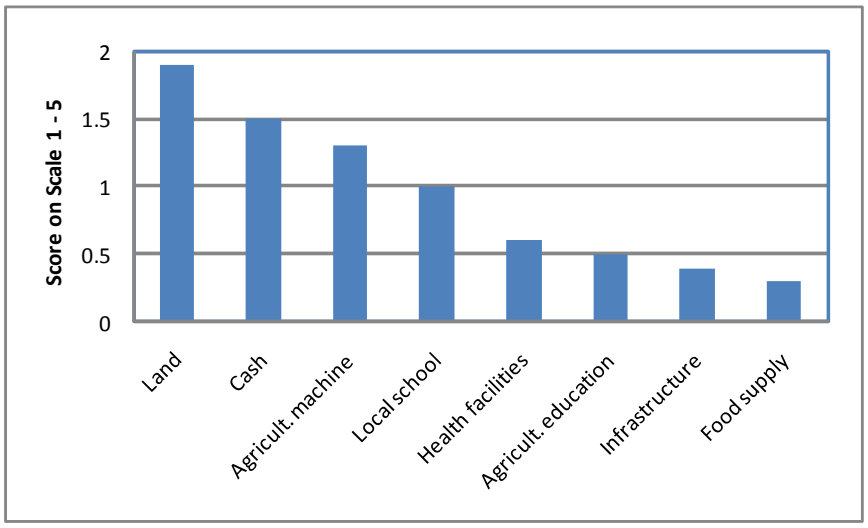


Figure 6.17 Preferred compensation for restricted forest use on a scale from 1 to 5.

The two communes of Trapeang Rung and Thma Doun Pov have agricultural machine ranked as the most preferred way of compensation. What is common between the two communes is that there is a relatively high rate of forest clearing occurring. This could indirectly mean that an agricultural machine may help them improve land cultivation and prevent them from clearing more forest.

Surprisingly, only one commune has cash ranked as the highest compensation; Chi Phat. Chi Phat is a commune where local people are especially vulnerable to a restricted forest

use; they have low income, they have to clear land due to low soil fertility and they have a very high dependency on forest products.

To be successful, a REDD project has to address some or all of these compensation measures. It is of utmost importance to pay particular attention to the poorest members of society, as these will often be the individuals that degrade forest through necessity. By assisting local communities in securing land titles, and providing agricultural intensification and education, clearing of forest and forest degradation can be reduced. Investing in instruments to satisfy local needs will reduce the cost burden that they feel and inevitably pay double dividends: guaranteeing emission reductions and lowering project risk.

6.4 Summary

The socio-economic assessment shows that local people in the Southern Cardamoms are dependent on natural resources, especially land and forest products. REDD activities will inevitably restrict these livelihood sources for local people, and compensating people in some form is therefore advisable. The local people in the Southern Cardamom have already been living under strict forest control during the last five years. This is a plus for the REDD project in the way, that the enforcement system is set-up and that it is already proven that the enforcement is reducing deforestation. But it is also a drawback that only little has been done to date to assist local people, which has resulted in a very negative attitude towards Wildlife Alliance. To secure real low-risk emission reductions, it is of utmost importance that local people and their needs are in focus and that the short-term solution of enforcement is combined with long-term assistance to create alternative livelihoods and assure that local people are direct beneficiaries of forest protection. However, when considering compensation measures, it should be noted that the stated compensation by local people is quite high and considerably influenced by what is offered. Therefore, care must be taken when designing compensation schemes so that a balance is found between what compensation is acceptable for locals to reduce deforestation and what is affordable considering the financial carbon benefits.

7. Lessons learned

7.1 Conclusions

This study has estimated the potential for REDD carbon benefits in the Southern Cardamom ecosystem. The core of the REDD project consists of the deforestation reducing activities included in the proposed Master Plan for the region by Wildlife Alliance and the Cambodian Forestry Administration. The potential amount of carbon benefits that can be generated are dependent on several overarching and overlapping factors, spanning from technical aspects to institutional and socio-economic conditions.

The technical potential for carbon benefits is centred upon a comparison of CO_2 emissions between a "without" and "with" project scenario. The two main building blocks are the carbon density of the forest/replacing land use and the deforestation rates under the "without" and "with" project scenarios. The average carbon density for above- and belowground biomass pools was estimated to be 135.6 tC/ha, equalling a potential gross emission of 497 tCO2/ha if deforestation occurs. Two scenarios were presented to provide a range for the "without" project deforestation rate. The lower bound (0.19 percent/yr) was based on historical deforestation in the project area while the upper bound (0.6 percent/yr) was based on recent deforestation rates in the surrounding region.

The "with" project scenario is based upon the Master Plan for the region and aims to implement several measures to reduce deforestation in the project area. These measures include agricultural support, ecotourism, institutional development, increased forest protection, community forest establishment, and reforestation. If the REDD project is successful it will reduce deforestation to a minimum resulting in a total avoided emission of between 10 and 36.6 million tCO_2 over a 30 year period compared to the "without" project. This volume therefore represents the total technical carbon potential for the region. However, the amount of this technical potential that can be harnessed is dependent on how much deforestation can be reduced.

However, to reduce deforestation substantially, the REDD project activities must address the drivers of deforestation effectively. The drivers of deforestation in the Southern Cardamoms are many and varied, with the most important being economic land concessions, land encroachment and infrastructural development. Each of these drivers is related to the institutional and socio-economic conditions prevailing in the area.

On the institutional side, the granting of large-scale economic land concessions, together with insecure land title, are the most important issues to be addressed. Both have had heavy impacts on forest cover as well as human rights and rural livelihoods and present a significant challenge for the future. Securing local land tenure throughout the entire project area is a priority for future progress and should eliminate the spiralling damaging effects of local land conflict.

In relation to the socio-economic conditions, it was found that people in the Southern Cardamom ecosystem are highly dependent on natural resources. Being a region with low agricultural yields and rapidly increasing population, people have traditionally been dependent on clearing land as well as collecting forest products during the dry season. Inevitably, some locals are and will be negatively affected by forest use restrictions

implemented by the REDD project. Of concern is the fact that it is mainly the poorest fraction of the population that are dependent on forest products and on clearing land, and these will therefore bare the cost of restrictions the most. To secure equity, reduce project risk, attract interest from investors, and ensure a premium price for the carbon credits, the REDD project should focus on local people that are negatively affected and assist in making them benefit from forest conservation.

While there still remains much work to be done before carbon benefits can be realised the outlook for REDD in the Southern Cardamoms is encouraging. Wildlife Alliance has a proven track record that they can reduce deforestation in the region and have a strong and integrated working collaboration with the governmental institutions. Widespread governmental support for REDD programs in Cambodia and International interest in cost-effective carbon mitigation means the forest of the Southern Cardamoms is likely to stay intact over the coming years, and if REDD project design and implementation is thorough and equitable, forest conservation may well also provide multiple co-benefits for the region to be enjoyed by all.

7.2 Recommendations

In this section the necessary steps towards verification will be presented. Regarding the two available standards, the VCS standard is generally more demanding from the carbon accounting point of view and more technical issues, while the CCBS is more demanding in project design and co-benefits for biodiversity and communities. Both standards have their differences, but they also overlap in many circumstances and complement each other well. While not necessary, a combination of the standards will make the carbon credits more robust, attracting more buyers and demanding a higher price. Upon the findings of this report, there are a number of core actions that need to be undertaken for the project to qualify for the recognised standards. A general approach that will fulfil the carbon requirements of both VCS and CCBA will be given, assuring real and quantifiable emission reductions. This will be combined with recommendations on how to create a successful project that ensures benefits not only for the environment but also for the local communities.

1. *Define the boundaries of the REDD project. This includes spatial boundaries, temporal boundaries and carbon pools.*

The spatial boundaries include: the project area, the reference region, and the leakage belt. The MAFF area should be established as the REDD project area. The reference region should be 5-7 times the size of the project area so must encompass the surrounding provinces. The leakage belt shall form a larger perimeter around the project area and include all areas where “without” project activities are likely to be shifted.

The temporal boundaries include; the historical reference period, the start date and end date of the project activity, the start date and end date of the crediting period, and the monitoring period. The historical reference period shall go back 10-15 years from present. The project start date should be as soon as possible since project activities are already underway. The project end date is optional, but can be no less than 20 years and no more than 100 years. The crediting and monitoring periods need to be further assessed to see which timeframe is most efficient.

Regarding carbon pools, the project is free to choose from the 5 pools mentioned in chapter 4. The aboveground biomass is the only mandatory carbon pool, and the below-ground biomass is recommended. While the remaining carbon pools will increase carbon stock, there is a trade-off between how much benefits they will provide and increase in costs of measurement. Therefore, it is recommended that only above- and below- ground biomass is considered for project start up.

2. *Analysis of historical land-use and land-cover change in the project area, reference region, and leakage belt over the defined historical reference period.*

To fulfil this requirement, GIS maps should be produced over the defined historical reference period for at least three points in time, 3-5 years apart. These maps will give vital information on deforestation trends and land-use/land cover-change needed for the establishment of a credible "without" project scenario and for future monitoring and adjustment of the "without" project scenario. The most recent map should be as close to the project start date as possible. The BioCarbon Fund (2008) and Brown *et al.* (2007) provide guidance on how these maps should be produced, and what standards should be followed.

3. *Analysis of the agents, drivers and underlying causes of deforestation.*

As described in Chapter 3, the agents, drivers and underlying causes of deforestation in the project area are varied, overlapping and complex. Analysing these will help to estimate the quantity and location of deforestation and help design effective measures to combat against them. As Wildlife Alliance has been operating in the project area since 2002 they already have a good understanding of the dynamics of deforestation in the region. The BioCarbon Fund (2008) provides guidance and methodology for this analysis based on earlier work by Angelsen and Kaimowitz (1999) and Chomitz *et al*. (2006). While this report provides a basis for the analysis, it is recommended that further research is done to uncover how agents and drivers of deforestation are targeted effectively.

4. *The Without project Deforestation Rate*

It was described in Chapter 4 that there are two approaches to establish the "without" project emission rate; the Linear Approach and the Modelling Approach. It is recommended to adopt the modelling approach as conditions within the project area are expected to change in the future. This approach relies on information gathered on the key drivers of deforestation and on land use/land use change observations made in the reference region over the historical reference period. This information can then be used as input for a spatial deforestation model. Geomod is a model that has been routinely used to establish "without" project deforestation for other similar projects (Pontius and Chen 2006).

5. *Increase Accuracy of Carbon Estimates*

The carbon density estimate in Chapter 4 was limited by assumptions and aggregated data. Although the core carbon density data from Top *et al.* was most suitable, they may not truly reflect the carbon densities of the forest within the project area. Additionally, the forest disturbance model was designed to give the carbon estimate a more realistic and conservative figure, but it too is constrained by high levels of uncertainty. It is

therefore recommended that a more detailed study be undertaken to produce more accurate carbon density estimates for the different strata of forest cover.

Estimations can be made using existing forest inventory data. The presence of logging concessions operating in the region in the past may well have produced inventoried forest stand or stock tables. Archard (2008) describes methods of estimating carbon stocks using these data sources. If however, there is no inventory data available, or that the data proves to be insufficient or unreliable, carbon densities can be measured by establishing sampling plots and measuring tree diameter at breast height (dbh). Methods of procedures for this are well established and can be found by referring to BioCarbon Fund (2008) or MacDicken (1997).

It should be noted that literature estimates can be used to attain validation from the carbon standards but the estimates used must adhere to conservative principles. This will be the most cost effective option in the short term but will more than likely underestimate carbon densities and therefore the overall carbon benefits.

6. Securing a successful environmental and equitable project

To secure environmental benefits, a REDD project must ensure real emission reductions. This is only done by assuring that the project is additional, that leakage and non-permanence are minimised and that the agents and drivers of deforestation in the region are addressed effectively. The first step is to prove additionality by passing an accepted additionality test. The most widely accepted additionality test for forestry projects is that of the CDM. The VCS (2007) provide alternative additionality tests that may also be considered. Leakage and non-permanence are closely related and minimising their effects will largely depend on the degree to which the agents and drivers of deforestation are addressed. There are a number of key issues identified in the institutional and socio-economic assessment, that need special attention to ensure that emission reduction are maximised and the effect of leakage and non-permanence minimised.

First of all, it should be recognised that it is the local communities that have and will bear the costs of reducing deforestation, and it is therefore important that the measures to support them are implemented as one of the first steps. The main areas that should be in focus to assure a successful project are:

- FA and Wildlife Alliance should assist locals in securing land tenure;
- Development of a comprehensive alternative livelihood program covering the entire project area and not only focus on the three communities mentioned in the Master Plan;
- A financial plan should be developed defining the allocation of carbon benefits to the different parts of resource dependent communities;
- Ensure local user rights to forest resources are upheld. This should include a clear definition of what can legally be utilised from the forest, and local people should be made aware of these limitations;
- Communities should be made aware of REDD activities to ensure project transparency and be explained what protecting the forest will have of benefit for them;
- Set-up of community council who can participate in decision making surrounding REDD development and implementation as well as benefit distribution.

Second, the contractual agreements are of utmost importance. The REDD agreement with the Cambodian government could follow suit to the pilot REDD project established in Oddar Meanchey (RGC 2008a). As owners of the forest carbon, the RGC Forestry Administration should be designated the suppliers/sellers of carbon credits. Regarding the revenues generated from selling carbon credits, it should be made clear how these benefits are distributed among the stakeholders, and the Memorandum of Understanding should include provisions for benefits to be returned to local communities participating in the REDD project. Finally, it is also recommended that Wildlife Alliance work closer with the government/FA, as well as other NGO's involved in REDD projects in the region. For example, Wildlife Alliance could share map expenses with Conservation International, who are initiating a REDD project in the Central Cardamoms. Working together may not only increase interest in the REDD project but also induce innovation, reduce leakage and lower transaction costs.

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Appendix I. Forest and deforestation definitions

Forest

A single universal definition of forestland is complicated by the variability of vegetation and land cover that different parties consider to be forest. However, this definition is critical when considering REDD activities, as it will have larger implications for the follow-on definition of deforestation.

The UNFCCC agreed that forestland should include all land with woody vegetation that is consistent with the thresholds that define forest, decided upon by each country in its national greenhouse gas inventory. Although this gives rise to a myriad of forest definitions, each country must select an individual minimum threshold for common forest criteria; tree height, area of land covered, and percent canopy cover.

The Marrakech Accords paved the way for definition of forest for the Kyoto Protocol. The definition remains somewhat flexible; each country must choose a single figure for forest area, tree height, and crown density within the following ranges:

- A minimum forest area of 0.5-1 ha;
- Potential to reach a minimum height at maturity *in situ* of 2-5 m;
- A minimum crown cover 0f 10-30%.

The FAO's global forest resource assessment 2005 (FAO 2005a), use a slightly more rigid definition of forestland, which was also adopted by the IPCC (IPCC 2006, table 4.2). Land is considered forestland if the following criteria are met:

- Minimum forest area of 0.5 ha;
- Minimum tree height of 5 meters;
- Minimum canopy cover of > 10%, or trees able to meet these requirements *in situ*.

Deforestation

Deforestation is characterized by the conversion of land from forest use to a non-forest use. The UNFCCC has defined deforestation as '...the direct, human-induced conversion of forested land to non-forested land' (UNFCCC 2008). This means that to be classified as deforestation, an area of land must fall from above a selected threshold definition of forest, to below that threshold.

When reporting deforestation trends for RED, only gross deforestation is considered relevant (Achard 2008, BioCarbon Fund 2008). This means that only forest becoming non-forest is accounted for, and not non-forest becoming forest. The gross deforestation rate applied to the project area, and subsequently projected into the future (i.e. the "without" project deforestation rate), has pivotal implications for the amount of potential carbon credit benefits.

Appendix II. Forest cover

Table II.1 Forest cover of the project area.

Land Classification	Hectare (ha)	Land Cover (%)	Forest Cover %
Evergreen forest	461,731	75.6	87.7
Semi-evergreen forest	16,581	2.7	3.1
Deciduous forest	28,213	4.6	5.4
Other forest	20,083	3.3	3.8
Total forest area	526,608	86.2	
Wood shrub dry	17	0.0	
Wood shrub evergreen	11,975	2.0	
Non-forest	72,296	11.8	
No data	32	0.0	
Total non-forest area	84,319	13.8	
Total area	**610,927**	**100**	**100**

Note: The FA's data was used from the Cambodian forest cover assessment for 2005/2006 (Forestry Administration 2008a). Calculations were made using ArcGIS. Maps were based on LanSat imagery 30x30 m resolution.

Table II.2 Disturbed Forest cover of the project area, as according to the forest disturbance model.

Forest type	Disturbed	Less disturbed	Intact	Total
Evergreen	151,609	81,062	229,061	461,731
Semi-evergreen	9,948	964	5,670	16,581
Deciduous	23,774	750	3,689	28,213
Other	14,568	3,091	2,423	20,083
Forested area	**199,899**	**85,866**	**240,843**	**526,608**

Appendix III. Forest clearance

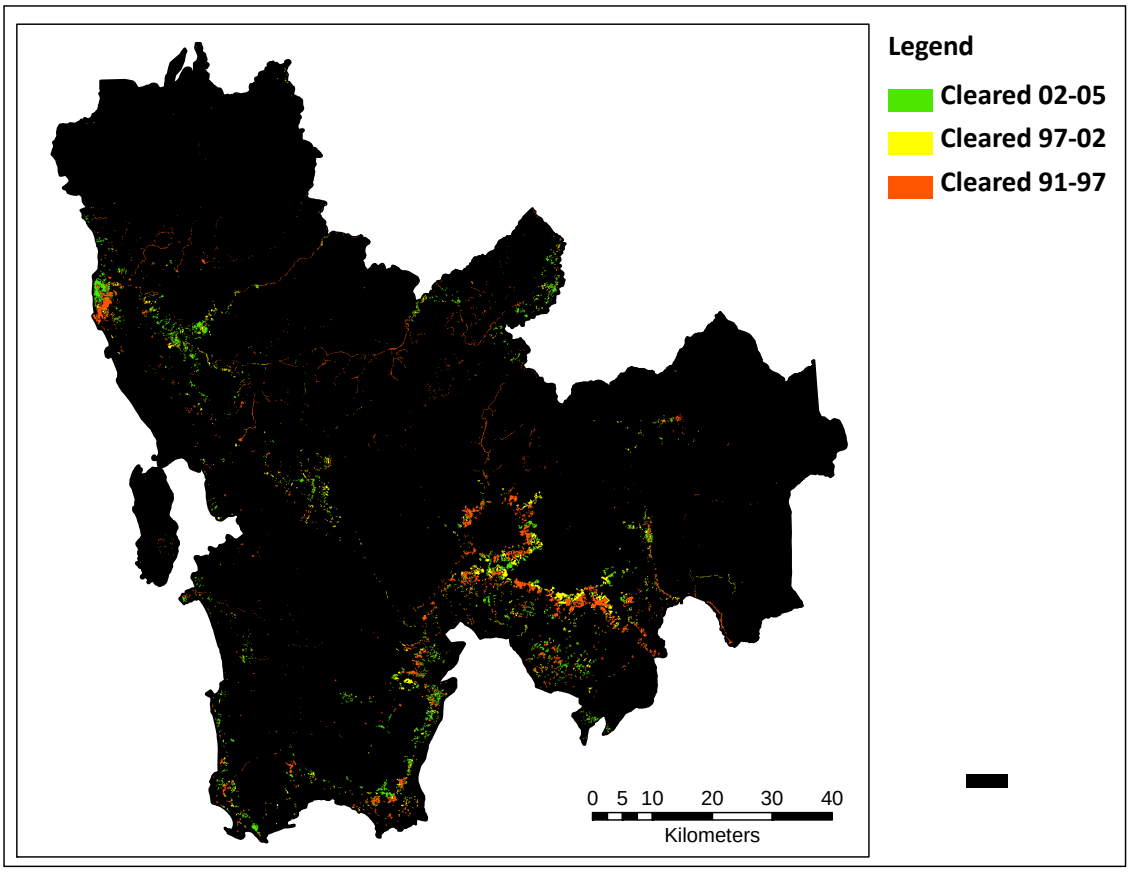


Figure III.1 Forest Clearing from 1991-2005. Aruna 2008.

Appendix IV. Surveyed villages

Village	Commune	District	Number of households	Number of surveys
Chi Phat	Chi Phat	Thma Bang	165	35
Choam Sla	Chi Phat	Thma Bang	112	37
Komloat	Chi Phat	Thma Bang	147 (?)	22
Trapeang Chheu Trav	Russei Chrum	Thma Bang	87	40
Kokir Chrum	Russei Chrum	Thma Bang	106	29
Kaoh Khang	Russei Chrum	Thma Bang	?	1
Thma Doun Pov	Thma Doun Pov	Thma Bang	?	15
Preak Svay	Thma Doun Pov	Thma Bang	47	5
Vealta Pur	Trapeang Rung	Kaoh Kong	?	25
Dei Tumneab	Trapeang Rung	Kaoh Kong	117	12
Kaoh Kong Knong	Trapeang Rung	Kaoh Kong	52	18
Preaek Angkonh	Trapeang Rung	Kaoh Kong	37	7
Veal Tumnearp	Trapeang Rung	Kaoh Kong	?	4
Trapeang Rung	Trapeang Rung	Kaoh Kong	246	4
Kaoh Andaet	Ta Tai Kraom	Kaoh Kong	78	17
Anlong Vak	Ta Tai Kraom	Kaoh Kong	121	27
Tuol Kokir Kraom	Tuol Kokir	Mondol Seima	42	5
Tuol Kokir Leu	Tuol Kokir	Mondol Seima	44	8
Prolean	Kandaol	Botum Sakor	339	14
Ksachshor	Kandaol	Botum Sakor	?	3
Chi Treh	Andoung Touk	Botum Sakor	79	36
Ta Ok	Andoung Touk	Botum Sakor	74	24
Chamkar Leu	Thma Sa	Botum Sakor	192	20
Srae Thmei	Thma Sa	Botum Sakor	159	15
Srae Trav	Thma Sa	Botum Sakor	133	13

Appendix V. Household survey

A SURVEY OF FOREST DEPENDENCY IN SOUTHERN CARDAMOM ECOSYSTEM

Hello. My name is __ I am a volunteer conducting a survey for Vrije University in the Netherlands. This survey is part of a larger study on forest use and dependency in the Southern Cardamom Ecosystem. The main objective of the survey is to uncover what the local people use the forest for and how much their livelihoods depend on this use.

Your household is randomly selected to be part of the study. For this survey I would like to request that only the head of the household (husband/wife/ or working adult children) could answer a series of questions. Your opinion and cooperation is very important for the successful completion of this study. There is no right or wrong answer to the questions; we only want your honest opinion. Your responses and your identity will be held strictly confidential.

Date of interview
Location of interview
Interviewer/enumerator
ID number

0. Interviewer, record the size of the house as well as the main material of the walls and roof of the house **without asking.**

a. Walls

1. ☐ Bamboo
2. ☐ Wood
3. ☐ Zinc
4. ☐ Thatch/leaves
5. ☐ Brick/cement
6. ☐ Other (specify):_____

b. Roof

1. ☐ Thatch/leaves
2. ☐ Tile
3. ☐ Zinc
4. ☐ Fibro
5. ☐ Concrete
6. ☐ Other specify):_____

Section 1: Household, housing & income

1. Gender ☐ Male ☐ Female

2. What is your age? _____

3. What is your position in the family?

1. ☐ Father
2. ☐ Mother
3. ☐ Child
4. ☐ Grandparent
5. ☐ Other (specify):_____

4a. Were you born here? ☐ Yes ☐ No

If **NO** **4b.** Where were you born (region and country)?_____

4c. When did you arrive here?_____

4d. Why did you move to this region? _____

5. Including yourself, how many people are living in your household? _____

6. How many of these people are above the age of 15? _____

7. Including yourself**,** how many people in your household above the age of 15 can read and write?
_____

8a. Do all children between the age of 6 and 15 in your household attend school?

☐ Yes ☐ No

If **NO** **8b.** Why do they not attend school?

1. ☐ No children between 6 and 15
2. ☐ Because we cannot afford the school fees
3. ☐ Because we need the children to help out at home/at work
4. ☐ Because the school is too remote
5. ☐ Other (specify):_____

9. What is the highest level of education in the household?

1. ☐ No schooling
2. ☐ Primary school
3. ☐ Secondary school
4. ☐ High School
5. ☐ University
6. ☐ Other (specify):_____

10. Could you indicate whether your household has the following items?

		Present in household (0=No, 1=Yes)
1.	Running water inside house	
2.	Electricity	
3.	A radio	
4.	A TV	
5.	Latrine in the household	
6.	A watch or a clock	
7.	A bicycle	
8.	A motorcycle	
9.	A car/truck/tractor	
10.	Row boat	
11.	Boat with motor	
12	Horse cart/ox cart	

11. I will now mention several practices that may contribute to your household's livelihood. Please indicate whether each of the following practices is very important, important or not important to your household's livelihood (Place a (√) mark)

		Very important	Important	Little importanceee	Not important	Don't know
1.	Cultivating Crops					
2.	Raring livestock					
3.	Using resources from the forest					
4.	Using resources from the mangroves					
5.	Fishing (fish, shrimps, crabs)					
6.	Labouring					
7.	**Other** (specify)_____					

12a. Does your household use a piece of land for growing food and/or livestock?

☐ Yes ☐ No

If **YES** **12b.** How big an area is this piece of land? _____(area)_____(unit)

12c. For the land you use, which of the following statements is true regarding the land title?

1. ☐ I own the land title
2. ☐ I rent the land from the land title owner
3. ☐ I partly own, and partly rent land
4. ☐ I don't have a land title
5. ☐ I don't know

Section 2: Usage & Dependency of the forest

Many local people situated in this region have several usages of the forest/mangroves on which their livelihoods depend. This section of the survey will focus on your household's usage and dependency of the forest/mangroves.

13a. Did your household clear any new forest/mangrove area during the last 5 years?

☐ Yes ☐ No

If **YES** **13b.** How big a forest/mangrove area have you cleared during this time period?

_____(area)_____(unit)

13c. When did you last clear a piece of forest/mangroves? _____(year)

14a. What are the four main products from the forest/mangroves that your household use? (Let the respondent identify these before you ask him to rank, place a (√) mark in *Main Use*)

14b. Please, rank them from most important to fourth most important. (Place a (√) mark)

14c. (Interviewer, you should now ask following question to the respondent for each of the four main uses) Do you use _____ mainly for your household's own consumption or mainly for sale?

		Main use	1st	2nd	3rd	4th	Used for: a) mainly for domestic use b) mainly for sale c) equal mix
1.	Firewood						
2.	Charcoal						
3.	Timber for construction						
4.	Resin tapping						
5.	Rubber						
6.	Wild meat						
7.	Fruits/Vegetables						
8.	Rattan						
9.	Spices/herbs						
10.	Medicine						
11.	Fishing						
12.	Other (specify)_____						

15. Now I would like to read a list of statements on the use of forest/mangroves. Can you indicate to what extent you agree or disagree with each of these statements. (Place a (√) mark)

		Agree	Neutral	Disagree	Don't know
1.	Because the use of the forest/mangroves has become restricted, our livelihood has decreased				
2.	If my land becomes infertile I have to clear another part of the forest for agriculture				
3.	Clearly defined land titles would reduce deforestation/destruction of forest/mangroves				
4.	The poorest households have a higher usage of the forest/mangroves				
5.	I feel that my use of the forest/mangroves is restricted by the law				
6.	The forest/mangroves are an important part of my community's social and cultural identity				

Section 3: Awareness

Major deforestation and degradation of the forest and mangroves occurred in Cambodia during the last decade. This has not only had consequences for the forest itself, but also affected the livelihood of many local people. The following questions attempt to understand what you think about the current forest situation.

16. Do you feel that your surrounding forest/mangroves are threatened by deforestation?

☐ Yes ☐ No ☐ Don't know

17a. Have you noticed any change in the health of the forest/mangroves, such as deforestation and degradation, over the last 5 years?

☐ Yes ☐ No ☐ Don't know

If **YES** **17b.** I will now read a list of possible causes for the change in health of the forest/mangroves. What do you think are the three main causes for this change? (Let the respondent identify these before you ask him to rank, place a (√) mark in *Main cause*)

17c. Can you please rank them from the most important to the third most important? (Place a (√) mark)

		Main cause	1st	2nd	3rd
1.	Forest clearance for small-scale agriculture				
2.	Forest clearance for Commercial Plantations				
3.	Firewood				
4.	Charcoal production				
5.	Land encroachment				
6.	Fires				
7.	Illegal Logging				
8.	Other (specify)_____				

18. Now, I will read a list of statements on the state of the forest/mangroves and the development of the road 48. Can you indicate to what extent you agree or disagree with each of these statements that you might have witnessed over the last 5 years? (Place a (√) mark)

		Agree	Neutral	Disagree	Don't know
1.	It's harder to get products from the forest/mangroves				
2.	There are less animals in the forest/mangroves				
3.	The forest/mangrove area are smaller and there are fewer trees				
4.	Certain species of trees are getting more scarce				
5.	Increases in jobs and income is more important than protecting the forest				
6.*	The road is bringing increases in jobs and incomes, to the region				
7.*	The road is causing increased logging and land encroachment				

*In Chi Phat area statement 6 and 7 in question 18 should not be asked

Section 4: Compensating Measures

Many people in this area are very dependent on the use of the forest. Over the last few years, control of the use of the forest has increased. However, some people still need to clear forest land and cut timber in the forest to support their family's livelihood. Suppose the level of control of the use of the forest was further increased so that from now on you're household could no longer clear forest or extract live wood.

Suppose in order to make up for asking you to completely stop clearing forest and extract live wood, you are given _____ $ every year from now on.

19. Would this be enough to make you stop clearing forest and extracting live wood?

☐ a. Yes ☐ b. No

a. If **YES**, would ____ $ per year make you stop clearing forest and extracting live wood?

1. ☐ Yes 2. ☐ No

b. If **NO**, would ____ $ per year make you stop clearing forest and extracting live wood?

3. ☐ Yes 4. ☐ No

20. What is the minimum amount of dollars you are willing to accept per year to make you stop clearing forest and extracting live wood?

_____ ($ per year)

21a. Suppose you could choose the type of compensation for a restricted forest use. What three forms of compensation would you prefer from the following list that I will read to you now? (Let the respondent identify these before you ask him to rank, place a (√) mark in *Preferred*)

21b. Can you please rank them from most preferred to third most preferred (Place a (√) mark)

		Preferred	1st	2nd	3rd
1.	Compensation in cash				
2.	Pesticides and fertiliser				
3.	Provide agricultural education				
4.	Assistance in finding/improving markets for goods				
5.	Extra food supply				
6.	Provide local education facilities for your children				
7.	Provide health facilities for your family				
8.	A piece of social concession land to grow crops on				
9.	Other (specify)				

22. If you receive this compensation would you then be willing to voluntarily take part in a patrolling-team that monitors the forest for illegal activities, such as forest encroachment and logging.

☐ Yes ☐ No

23. What is the approximate income of your household per month?

_____(amount) _____(currency)

24. Is the forest surrounding your village protected by law?

☐ Yes ☐ No ☐ Don't know

25. Do you know it is illegal to cut trees in protected forests?

☐ Yes ☐ No

26a. I will now read a list of possible reasons why people cut trees in protected forest/mangroves. What do you think are the two main reasons? (Let the respondent identify these before you ask him to rank, place a (√) mark in *Main Reason*)

26b. Can you please rank them from the most important to second most important reason (Place a (√) mark).

		Main Reason	1st	2nd
1.	There is no control			
2.	The fines are very low			
3.	They have to survive			
4.	They don't know it's illegal			
5.	Other (specify) _____			

Would you like to add any comments about the survey or do you have any questions?

_____
_____

Duration of the interview. …. Minutes

Thank you very much for your cooperation and help

Appendix VI. Household survey – descriptive statistics

All results are based on 436 respondents unless else has been indicated

Section 1: Household, housing & income

1. Gender

	Frequency	Percent
Female	245	56
Male	191	44
Total	436	100

2. What is your age?

Mean	Median	Mode	Stdev	Variance	Min	Max	Skewness	Kurtosis
40	40	40	14	198	18	88	0.69	0.20

3. What is your position in the family?

	Frequency	Percent
Father	158	36
Mother	219	50
Child	36	8
Grandparent	16	4
Other	7	2
Total	436	100

4a. Were you born here?

	Frequency	Percent
No	202	46
Yes	234	54
Total	436	100

If **NO** **4b.** Where were you born (region and country)?

	Frequency	Percent	Percent of total HH's
Koh Kong	31	15	7
Kompot	57	28	13
Kompong Speu	17	8	4
Kampong Cham	23	11	5
Takeo	31	15	7
Kompong Som	12	6	3
Kandal	7	3	2
Svay Rieng	4	2	1
Prey Veng	7	3	2
Phnom Penh	6	3	1
Other	7	3	2
Total	202	100	46

4c. When did you arrive here?

Mean	Median	Mode	Stdev	Variance	Min	Max	Skewnes	Kurtosis
1995	1997	1979	9	73	1975	2008	-0.5	-0.7

4d. Why did you move to this region?

	Frequency	Percent	Percent of total HH's
Improve livelihood	117	58	27
Marriage	17	8	4
Follow relatives	37	18	8
Pol Pot	21	10	5
Army	10	5	2
Total	202	100	46

5. Including yourself, how many people are living in your household?

Mean	Median	Mode	Stdev	Variance	Min	Max	Skewness	Kurtosis
5	5	4	2	5	1	13	0.7	0.5

6. + 7. How many percent of the people in the household above the age of 15 can read and write?

(**6.** How many of these people are above the age of 15? + **7.** Including yourself**,** how many people in your household above the age of 15 can read and write?)

Mean	Median	Mode	Stdev	Variance	Min	Max	Skewness	Kurtosis
56	50	100	34	1189	0	100	-0.2	-1.1

8a. Do all children between the age of 6 and 15 in your household attend school?

	Frequency	Percent
Yes	413	95
No	23	5
Total	436	100

If **NO** **8b.** Why do they not attend school?

	Frequency	Percent	Percent of total HH's
Because we cannot afford the school fees	1	4	0.2
Because we need the children to help out at home/work	2	9	0.5
Because the school is too remote	14	61	3
Other	6	26	1
Total	23	100	5

9. What is the highest level of education in the household?

	Frequency	Percent
No schooling	49	11
Primary school	280	64
Secondary school	78	18
High school	17	4
University	3	0.7
Other	9	2
Total	436	100

10. Number of household items in the household

Mean	Median	Mode	Stdev	Variance	Min	Max	Skewness	Kurtosis
3	3	4	2	4	0	8	0.1	-0.7

11. I will now mention several practices that may contribute to your household's livelihood. Please indicate whether each of the following practices is very important, important or not important to your household's livelihood.

The result is given in percentages of total HH's

		Very important	Important	Little importanceee	Not important	Don't know
1.	Cultivating Crops	58	27	6	9	0
2.	Raring livestock	7	35	38	20	0.2
3.	Using resources from the forest	5	16	16	63	0.2
4.	Using resources from the mangroves	2	5	6	75	12
5.	Fishing (fish, shrimps, crabs)	24	39	11	26	0.5
6.	Labouring	11	12	9	65	3
7.	Selling	8	4	0.5	87	0

12a. Does your household use a piece of land for growing food and/or livestock?

	Frequency	Percent
No	47	11
Yes	389	89
Total	436	100

If **YES** **12b.** How big an area is this piece of land? **Result is given in hectares**

Mean	Median	Mode	Stdev	Variance	Min	Max	Skewness	Kurtosis
2.4	1.5	1.0	4.0	15.6	0.0	51.0	7.5	74.3

12c. For the land you use, which of the following statements is true regarding the land title?

	Frequency	Percent
I own the land title	150	39
I rent the land from the land title owner	40	10
I don't have a land title	195	50
I don't know	4	1
Total	389	100

Section 2: Usage & Dependency of the forest

Many local people situated in this region have several usages of the forest/mangroves on which their livelihoods depend. This section of the survey will focus on <u>your</u> household's usage and dependency of the forest/mangroves.

13a. Did your household clear any new forest/mangrove area during the last 5 years?

	Frequency	Percent
No	348	80
Yes	88	20
Total	436	100

If **YES** **13b.** How big a forest/mangrove area have you cleared during this time period?

Mean	Median	Mode	Stdev	Variance	Min	Max	Skewnes	Kurtosis
2.6	1.0	1.0	6.2	38.2	0.3	55.0	7.4	62.5

13c. When did you last clear a piece of forest/mangroves?

Mean	Median	Mode	Stdev	Variance	Min	Max	Skewnes s	Kurtosis
2004.8	2004	2003	1.7	2.9	2003	2008	0.5	-1.0

14a. What are the four main products from the forest/mangroves that your household use?

14b.Please, rank them from most important to fourth most important.

14c. Do you use _____ mainly for your household's own consumption or mainly for sale?

Result is given in percentage of total households.

		1st	2nd	3rd	4th	Total	Used for (in % of total): a) mainly for domestic use b) mainly for sale c) equal mix		
							a)	b)	c)
1.	Firewood	47	5	2	1	55	98	0.8	2
2.	Charcoal	5	10	2	0.5	16	69	20	11
3.	Timber for construction	0.5	0.9	0.5	0	2	88	0	13
4.	Resin tapping	0.5	1	0.2	0	2	0	88	13
5.	Rubber	6	8	3	0.2	17	11	87	3
6.	Wild meat	1	3	1	0.7	6	19	19	62
7.	Fruits/Vegetables	6	7	6	0.9	20	56	13	31
8.	Rattan	5	2	2	0.2	9	32	53	16
9.	Spices/herbs	0.2	0.5	0.5	0.2	1	100	0	0
10.	Medicine	0.2	0.5	0.9	0.2	2	75	13	13

15. Now I would like to read a list of statements on the use of forest/mangroves. Can you indicate to what extent you agree or disagree with each of these statements.

Result is given in percentage of total households.

		Agree	Neutral	Disagree	Don't know
1.	Because the use of the forest/mangroves has become restricted, our livelihood has decreased	65	5	27	3
2.	If my land becomes infertile I have to clear another part of the forest for agriculture	17	5	69	9
3.	Clearly defined land titles would reduce deforestation/destruction of forest/mangroves	89	1	2	8
4.	The poorest households have a higher usage of the forest/mangroves	68	5	19	8
5.	I feel that my use of the forest/mangroves is restricted by the law	93	3	1	3
6.	The forest/mangroves are an important part of my community's social and cultural identity	25	2	6	67

Section 3: Awareness

Major deforestation and degradation of the forest and mangroves occurred in Cambodia during the last decade. This has not only had consequences for the forest itself, but also affected the livelihood of many local people. The following questions attempt to understand what you think about the current forest situation.

16. Do you feel that your surrounding forest/mangroves are threatened by deforestation?

	Frequency	Percent
No	216	50
Yes	171	39
Don't know	49	11
Total	436	100

17a. Have you noticed any change in the health of the forest/mangroves, such as deforestation and degradation, over the last 5 years?

	Frequency	Percent
No	137	31
Yes	259	59
Don't know	40	9
Total	436	100

If **YES** **17b.** I will now read a list of possible causes for the change in health of the forest/mangroves. What do you think are the three main causes for this change?

17c. Can you please rank them from the most important to the third most important?

Result is given in percentage of total households

		1st	2nd	3rd
1.	Forest clearance for small-scale agriculture	39	8	9
2.	Forest clearance for Commercial Plantations	3	2	0.9
3.	Firewood	2	17	9
4.	Charcoal production	1	6	4
5.	Land encroachment	9	12	5
6.	Fires	0.4	1	2
7.	Illegal Logging	5	6	4
8.	No law	1	0.9	0.9

18. Now I will read a list of statements on the state of the forest/mangroves and the development of the road 48. Can you indicate to what extent you agree or disagree with each of these statements that you might have witnessed over the last 5 years? (Place a (√) mark)

		Agree	Neutral	Disagree	Don't know
1.	It's harder to get products from the forest/mangroves	66	2	18	14
2.	There are less animals in the forest/mangroves	62	6	16	16
3.	The forest/mangrove area are smaller and there are fewer trees	51	12	14	23
4.	Certain species of trees are getting more scarce	49	9	9	33
5.	Increases in jobs and income is more important than protecting the forest	71	4	9	16
6.*	The road is bringing increases in jobs and incomes, to the region	62	1	5	11
7.*	The road is causing increased logging and land encroachment	20	10	16	34

***** Based on 342 respondents – People in Chi Phat commune were not asked these two questions since they live far from the road

Section 4: Compensating Measures

Many people in this area are very dependent on the use of the forest. Over the last few years, control of the use of the forest has increased. However, some people still need to clear forest land and cut timber in the forest to support their family's livelihood. Suppose the level of control of the use of the forest was further increased so that from now on you're household could no longer clear forest or extract live wood.

Suppose in order to make up for asking you to completely stop clearing forest and extract live wood, you are given _____ $ every year from now on.

19. Would this be enough to make you stop clearing forest and extracting live wood?

☐ a. Yes ☐ b. No

a. If **YES**, would ____ $ per year make you stop clearing forest and extracting live wood?

1. ☐ Yes 2. ☐ No

b. If **NO**, would ____ $ per year make you stop clearing forest and extracting live wood?

3. ☐ Yes 4. ☐ No

	Frequency	Percent
1. < 150	6	1
2. 150 - 300	28	6
3. 300 - 450	17	4
4. > 450	36	8
5. < 225	6	1
6. 225 - 450	42	10
7. 450 - 675	18	4
8. > 675	21	5
9. < 300	12	3
10. 300 - 600	56	13
11. 600 - 900	13	3
12. > 900	7	2
13. < 375	10	2
14. 375 - 750	59	14
15. 750 - 1125	16	4
16. >1125	2	0
17. < 450	14	3
18. 450 - 900	59	14
19. 900 - 1350	9	2
20. > 1350	5	1
Total	436	100

20. What is the minimum amount of dollars you are willing to accept per year to make you stop clearing forest and extracting live wood?

Mean	Median	Mode	Stdev	Variance	Min	Max	Skewness	Kurtosis
656	600	600	323	104239.4	0	2000	0.9	2.0

21a. Suppose you could choose the type of compensation for a restricted forest use. What three forms of compensation would you prefer from the following list that I will read to you now?

21b. Can you please rank them from most preferred to third most preferred?

Result is given in percentage of total households

		1st	2nd	3rd
1.	Compensation in cash	17	15	19
2.	Pesticides and fertiliser	2	9	9
3.	Provide agricultural education	6	5	8
4.	Assistance in finding/improving markets for goods	3	7	8
5.	Extra food supply	3	5	7
6.	Provide local education facilities for your children	8	17	11
7.	Provide health facilities for your family	5	8	11
8.	A piece of social concession land to grow crops of	28	15	7
9.	Agricultural machine	16	12	7
10.	Improved infrastructure	5	3	3
11.	Other	7	4	6

22. If you receive this compensation would you then be willing to voluntarily take part in a patrolling-team that monitors the forest for illegal activities, such as forest encroachment and logging.

	Frequency	Percent
No	39	9
Yes	396	91
Total	435	100

23. What is the approximate income of your household per month? **Result is given in US$**

Mean	Median	Mode	Stdev	Variance	Min	Max	Skewness	Kurtosis
78	50	25	147	21702	0	2500	12.6	0.2

24. Is the forest surrounding your village protected by law?

	Frequency	Percent
Yes	425	97
No	0	0
Don't know	11	3
Total	436	100

25. Do you know it is illegal to cut trees in protected forests?

	Frequency	Percent
No	3	1
Yes	433	99
Total	436	100

26a. I will now read a list of possible reasons why people cut trees in protected forest/mangroves. What do you think are the two main reasons?

26b. Can you please rank them from the most important to second most important reason?

Result is given in percentage of total households

		1st	2nd
1.	There is no control	1	21
2.	The fines are very low	0.2	0
3.	They have to survive	97	1
4.	They don't know it's illegal	0.2	4
5.	Businessmen pay locals to do it	0.9	3
6.	Other (specify) _____	0.2	1

Appendix VII. Household survey – statistical tests

Table VII.1 ANOVA – test of difference in forest dependency (scale 0 to 5) between people that have cleared land within the last 5 years and people that have not (survey q. 11 and 13).

	N	Mean	Std. deviation	Std. error	95% confidence interval for mean		Minimum	Maximum
					Lower	Upper		
No	348	0.77	1.35	0.07	0.62	0.91	0	5
Yes	88	1.30	1.60	0.17	0.96	1.63	0	5
Total	**436**	**0.87**	**1.42**	**0.07**	**0.74**	**1.01**	**0**	**5**

	Sum of squares	df	Mean square	F	Sig.
Between groups	19.60	1	19.60	9.95	0.002
Within groups	854.46	434	1.97		
Total	**874.06**	**435**			

Table VII.2 Cross tab/Chi-square – test of difference between people that have cleared land and people that haven't in relation to agree/disagree to the statement that a restricted use of forest has reduced livelihood (survey q. 13 and 15).

			Have you cleared any forest during the last 5 years?		
			No	Yes	Total
Restricted use of forest has decreased our lively-hood	Disagree	% within REDD. livelihood	93	7	100
		% within cleared land	34	10	30
	Agree	% within REDD. livelihood	73	27	100
		% within cleared land	66	90	71
	Total	% within REDD. livelihood	79	21	100
		% within cleared land	100	100	100

	Value	df	Asymp. Sig (2-sided)
Pearson Chi-Square	19.195	1	0.00

Appendix VIII. Household survey – communal differences

A * indicates that there is a significant difference on a 0.05 level between the commune and one or several others. Bold writing indicates the number is significantly higher than the lowest, which is indicated by writing in italics and underlined. All results are calculated using ANOVA on the basis on the responses in the survey, where 1st most important equals 5 points, 2nd equals 3 and 3rd equals 1 (if there is four options, then 3rd equals 2 and 4th equals 1).

Table VIII.1 Average importance score of different livelihood practices for each commune and the survey area as a whole (total).

	Chi Phat	Trapeang Rung	Russei Chrum	Thma Doun Pov	Ta Tai Kraom	Tuol Kokir	Kandaol	Andoung Touk	Thma Sa	Total
Crops	**4.1***	3.6	**4.4***	**4.4***	**3.9***	3.5	2.9*	3.7	2.8*	3.8
Livestock	2.0	2.0	1.4*	**2.9***	1.9	1.0*	1.8	1.8	1.3*	1.8
Fishing	1.2*	**3.9***	1.7*	**3.3***	**2.5***	**2.8***	**2.4***	**3.1***	**2.9***	2.5
Labouring	0.6	0.8	**1.6**	0.1	**1.0**	**2.5**	**1.9**	0.4	**1.4**	1.0
Selling	**0.9***	0.2*	0.2	0.9	0.8	0.8	0.6	0.5	0.4	0.5
Forest	**1.8***	0.6*	0.5*	1.0	**1.2***	0.0*	0.0*	0.4*	0.8*	0.9
Mangroves	0.1*	0.4*	0.02*	0.05*	0.09*	0.6	0.0*	**0.7***	**1.0***	0.3

Table VIII.2 Importance of the main collected forest/mangrove products.

	Chi Phat	Trapeang Rung	Russei Chrum	Thma Doun Pov	Ta Tai Kraom	Tuol Kokir	Kandaol	Andoung Touk	Thma Sa	Total
Firewood	**3.2***	2.0*	1.4*	3.2	2.1	2.5	2.9	**3.0***	**3.0***	2.57
Charcoal	0.2*	**0.7***	0.04*	**1.7***	**0.9***	1.1	0.0*	0.6	**1.1***	0.56
Rubber	**1.8***	0.1*	0.4*	1.0	**1.0***	0.0*	0.0*	0.0*	0.0*	0.61
Wild meat	**0.4***	0.03*	0.0*	0.0	0.0*	0.0	0.0	0.4	0.2	0.17
Fruits	0.9	0.6*	**1.4***	0.4	0.7	0.2	0.0*	0.2*	0.1*	0.63
Rattan	0.04*	0.4*	0.1*	0.5	**1.3***	0.4	0.0*	0.5*	0.06*	0.34
Total	6.54	3.83	3.34	6.8	6	4.2	2.9	4.7	4.46	

Table VIII.3 Ranking of the main drivers of deforestation.

	Chi Phat	Trapeang Rung	Russei Chrum	Thma Doun Pov	Ta Tai Kraom	Tuol Kokir	Kandaol	Andoung Touk	Thma Sa	Total
Small scale	2.1*	2.0*	2.0*	3.0	1.8*	1.1*	1.5*	**3.7***	2.7	2.3
Commercial	0.3*	0.0*	0.04*	0.0*	0.0*	0.0*	**1.8***	0.3*	0.1	0.19
Firewood	0.5*	0.6	0.4*	1.4	0.7	0.08*	0.5	**1.3***	0.7	0.68
Charcoal	0.1*	0.2*	0.1*	**0.9***	0.1*	0.8	0.2	0.4	0.5	0.26
Land encroachment	0.5*	0.2*	0.7*	0.2*	0.7*	0.2*	1.2*	1.2*	**2.7***	0.84
Illegal logging	0.01*	**0.2***	0.0*	0.0	0.0*	0.0	**0.4***	0.0*	0.0*	0.048

Table VIII.4 Preferred type of compensation.

	Chi Phat	Trapeang Rung	Russei Chrum	Thma Doun Pov	Ta Tai Kraom	Tuol Kokir	Kandaol	Andoung Touk	Thma Sa	Total
Land	1.1*	1.3*	**2.9***	1.3	**2.6***	2.7	**3.2***	2.1	2.0	1.9
Cash	**2.1***	1.5	1.4	1.2	1.3	1.5	1.2	1.0*	1.1	1.5
Agricultural machine	0.4*	**1.9***	1.3	**2.2***	**1.9***	1.2	0.6	1.0	1.3	1.25
Local school	0.6*	1.1	0.4*	0.6	**1.5***	0.8	1.6	**1.8***	1.3	1.02
Agricultural education	**1.4***	0.5*	0.2*	0.6	0.2*	0.08*	0.3*	0.2*	0.3*	0.54
Health facilities	0.6	0.5	0.3	0.2	0.4	1.3	0.9	1.0	0.7	0.6
Infrastructure	0.6	0.4	0.6	0.9	0.3	0.0	0.0	0.08	0.0	0.37
Food supply	**0.8***	0.2*	0.3*	0.4	0.07*	0.08	0.2	0.3*	0.3*	0.34

Table VIII.5 Summary of main differences between communes in relation to pressures on the forest, local livelihood and preferred type of compensation.

	Chi Phat	Trapeang Rung	Russei Chrum	Thma Doun Pov	Ta Tai Kraom	Tuol Kokir	Kandaol	Andoung Touk	Thma Sa
Area (ha)	10,132	90,653	54,696	29,604	20,377	7,111	15,229	39,573	24,179
Clearing 2002-2005 (ha)	183	181	132	39	50	117	266	163	421
Clearing/area (%)	0.018	0.002	0.002	0.001	0.002	0.017	0.017	0.004	0.017
Population[23]	2,026	1,939	779	328	929	933	3,358	5,219	9,425
High pop. density	X						X		X
High immigration 2000-2008			X						
Low income	X							X	
High illiteracy		X						X	
High forest dependency	X				X				
No land title		X					X	X	X
Clear land when infertile	X							X	
Compensation land			X		X	X	X	X	X
Compensation agr. machine		X		X					
Reject start bid	X	X		X					

Note: Forest clearing from 2002-2005 in each commune has been estimated using maps and data from the Technical assessment. An X indicates that the commune is considerably different from other communes and that the concerned variable can have a negative influence on the forest resources and/or the livelihood of local people can be negatively affected by forest restrictions.

[23] Population in communes is based on data from Wildlife Alliance.

Appendix IX. Reforestation credits

The reforestation of 2,700 hectares around Chi Phat of natural species can be an important attribute to carbon finance. The aim is to restore natural forest by planting the same mix of tropical species present in the region. Seeds are collected in the forest by locals, and germinated in an outdoor nursery in Chi Phat. Currently, the nursery contains 60,000 seedlings, which are ready for planting. The seedlings will be planted 2.5 meters apart, resulting in 1,500 seedlings per hectare. After 6 years, the trees will be thinned to an average distance of 6-8 meter apart. The reforestation has just begun, and the plan is that the 2,700 hectares will be planted within 4 years.

Figure XI.1 The nursery, Chi Phat.

Figure XI.2 The reforestation area, Chi Phat.

To estimate how much carbon could be sequestered by the reforestation project, the IPCC default values for "above ground net biomass growth for natural forests" for "tropical rain forest" were used (IPCC 2006, Table 4.9). Since the project aims to replicate a natural forest system, it was thought that these figures were the most fitting. The values estimate that the forest will sequester an average of 12.1 tCO_2/ha/yr for the first 20 years of forest growth, and 3.8 tCO_2/ha/yr for each year after[24] in above ground biomass. Using the generally accepted root:shoot ratio of 20 percent and the above figures it is estimated that approx. 750,000 tCO_2 can be sequestered over a 30 year project period[25] in the form of above and below ground biomass. However, due to technicalities in the available carbon standards, not all of this carbon can be claimed. The following will explain why.

There are two possible markets for carbon credits from Afforestation/Reforestation projects; the regulatory market and the voluntary market, each with different standard requirements. The regulatory market requires the project to meet the CDM standard. One of the primary requirements of the CDM standard is that the planned reforestation area was cleared prior to 31st of December 1989 (UNFCCC 2007). The same requirements are due for the CCX (CCX 2006). One of the most widely accepted standard for the

[24] These figures were calculated using an above ground biomass carbon fraction of 0.47 and a C to CO_2 conversion factor of 3.667.

[25] This project period was used purely as an example of a possible timeframe.

voluntary market is the Voluntary Carbon Standard (VCS). This standard requires that the land has been cleared at least 10 years before the proposed project start (VCS 2007). To check to what extent the reforestation area fulfils the above requirements for each standard, a GIS overlay analysis was done using interpreted satellite imagery from 20th of November 1991 (which was the nearest year possible to 1989), and data from the FA for the 1997 analysis. These maps were overlaid with the two reforestation project boundaries i.e. Zone D1 and D2. The resulting maps can be seen below.

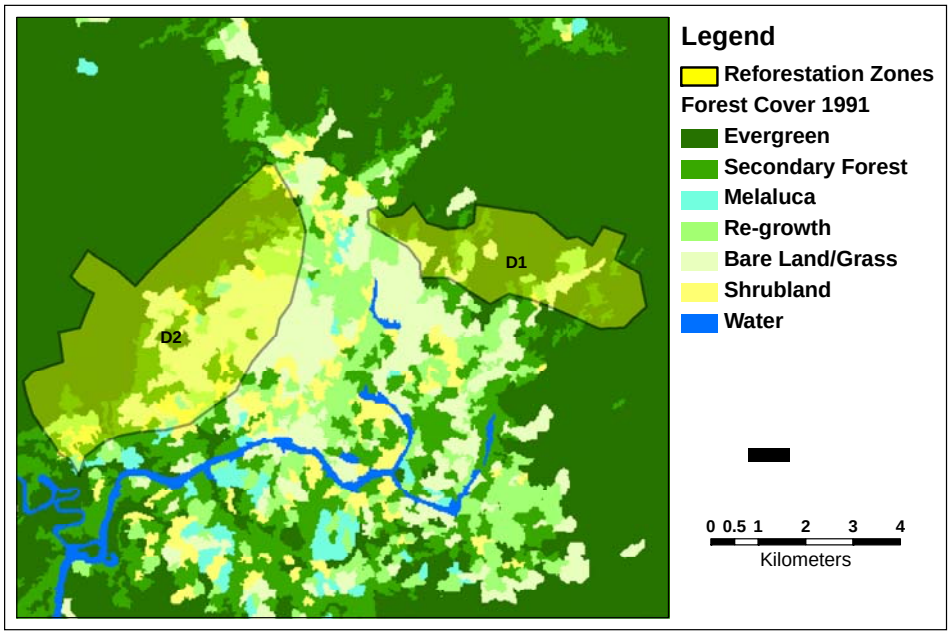


Figure IX.3 Area forested in reforestation zones in 1991.

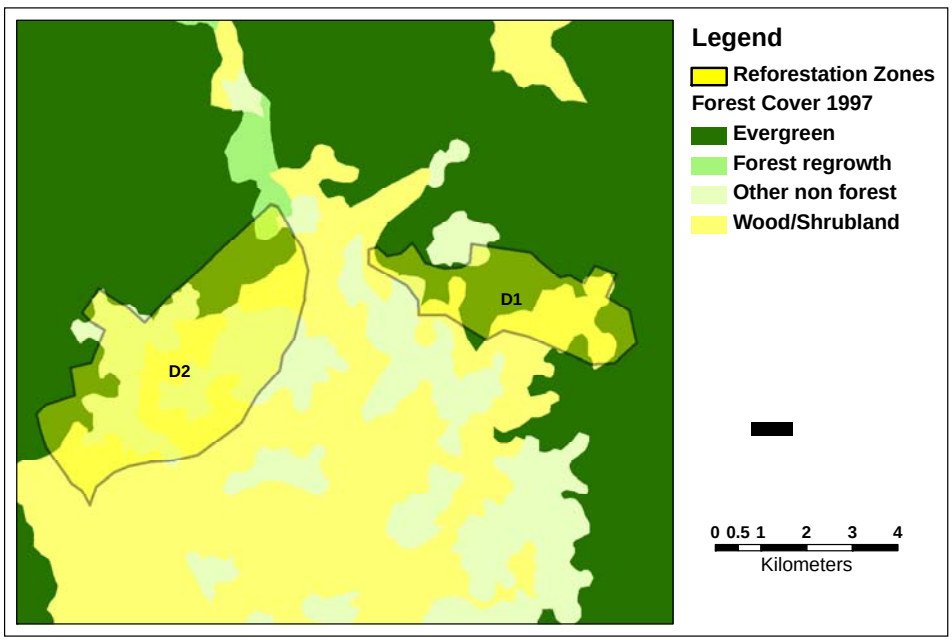


Figure IX.2 Area forested in reforestation zones in 1997.

Table IX.1 provides a summary of the findings.

Table IX.1 Land cleared before 1991 and 1997 for reforestation.

Cleared Land	Zone D1	Zone D2	**Total**
1991 (ha)	141	731	**872**
1997 (ha)	354	1,493	**1,847**

The analysis found that of the 2700, hectares zoned for reforestation, a total of 872 hectares was cleared prior 1991 and 1,847 hectares were cleared prior to 1997. This means that approx. 872 hectares are eligible to qualify for the CDM or the CCX, while approx. 1,847 hectares are eligible for the VCS.

Currently, the prices obtained from carbon credits generated through the regulatory CDM market is well above the price generated through voluntary carbon market. However, the share of CDM forestry projects approved remain relatively low, accounting for only 1 percent of the total CDM carbon volume in 2006. The voluntary forestry market is much healthier, with forest carbon accounting for 36 percent.

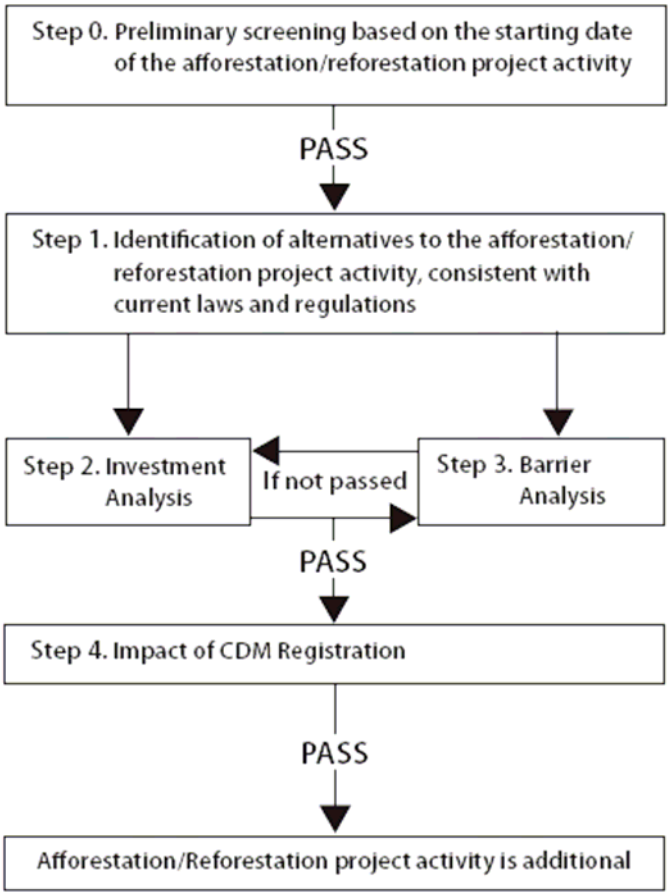
Table IX.2 shows the different estimates for carbon sequestration in above- and below ground biomass for both the CDM/CCX and VCS options.

Table IX.2 Annual estimates for CO_2 sequestration in above- and belowground biomass.

Carbon Standards	CO_2 Potential (tCO_2/yr)		**30 year Total**
	≤ 20 yr	> 20 yr	**(tCO_2)**
CDM/CCX - 872 (ha)	12,624	3,968	**292,161**
VCS – 1,847 (ha)	26,740	8,404	**618,831**

If a project period of 30 years is considered, the CDM/CCX eligible land is estimated to sequester approx. 292,000 tCO_2, while the VCS eligible land is estimated to sequester approx. 618,800 tCO_2.

Appendix X. Additionality



Adapted from Pearson *et al*. (2005).

Step 0. Preliminary screening based on the starting date of the REDD project activity

This step is not important if the project activity has not yet started. In this case, however, project activity has already begun. Evidence must be provided that the incentive of the planned sale of GHG emission reductions was seriously considered in the decision to proceed with the project activity. This evidence should be based upon official, legal, and /or other corporate documentation that was made available to third parties prior to the start date of the project activity.

Step 1 Identification of alternatives to the REDD project activity consistent with the current laws and regulations

Realistic and credible alternative land uses must be identified for the project area. This may include a continuation of the current situation or the proposed REDD project activity not undertaken as a REDD project. Each alternative shall be in compliance with all applicable legal and regulatory requirements. If the alternatives do not comply with

legal and regulatory requirements then it must be clearly demonstrated that current legal or regulatory requirements are systematically not enforced in the host country. If the REDD project activity remains to be the only alternative considered that complies with regulations with which there is general compliance, then the proposed project is not additional.

Project proponents may choose step 2 or step 3 or both.

Step 2 Investment Analysis

This step must prove that the REDD project activity is economically or financially less attractive than the other alternatives described in *Step 1*, without revenues generated from the sale of carbon credits. If the project activity is unlikely to be the most attractive option then one may proceed to *Step 4*. If the project fails this step it is necessary to complete *Step 3*.

Step 3 Barrier Analysis

This step must demonstrate that the project activity faces certain barriers preventing implementation. These barriers must also fail to prevent the implementation of at least one of the alternatives described in *Step 1*. Barriers may include investment barriers, Institutional barriers, technological barriers, prevailing practices barriers, etc. If the project activity fails to fulfil either *Step 2* or *Step 3*, the project is not additional.

Step 4 Impact of REDD implementation

This step must explain how the registration of the REDD project and the attendant benefits and incentives derived from this registration, will alleviate the financial of economic hurdles (*Step 2*) or identified barriers (*Step 3*) to enable the project to be undertaken. If this step is not satisfied the project is not additional.

To qualify for any recognized carbon standard the project proponents must justify that the emission reductions are truly additional by passing an additionality test. Project activities must not be required by law, otherwise project proponents must make a compelling demonstration that the pertinent laws are not being enforced (CCBA (2005) standard pass, VCS).

Appendix X. National forest cover trends

The Royal Government of Cambodia has made sustained efforts to monitor forest cover change throughout the 90s and up until 2005/2006. During this period, four forest cover maps have been produced based on LandSat imagery. Despite these efforts, lack of consistency in processing, classifications, and ground truthing, make the resulting figures incompatible and difficult to compare. Based on interviews with the Royal Government of Cambodia's GIS unit, Danida, and a GIS specialist from Aruna technologies, it was found that there is a distinct difference in the processing techniques, land cover classifications, and level of ground truthing between the pre- and post- 2002 maps, with a number of unusual trends the outcome. Several sources have attempted to "correct" for these inconsistencies. The result of this however, has produced conflicting forest cover estimates (FA 2008a, FAO 2005b, IFSR 2004). Figure X.1 provides an illustration of three different forest cover estimates.

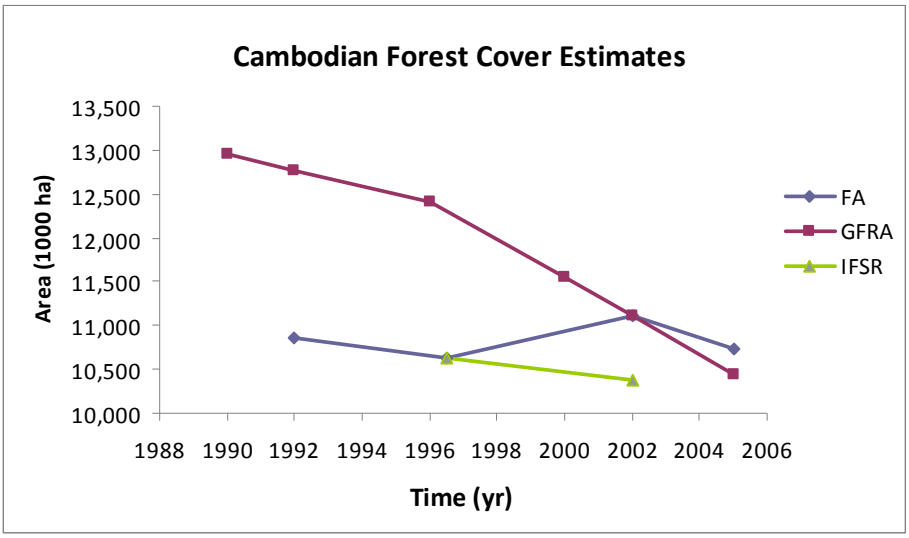


Figure X.1 Forest cover estimates by the Forestry Administration (FA 2008a), the Global Forest Resource Assessment (FAO 2005b), and the Independent Forest Sector Review (IFSR 2004).

Figure X.1 shows that the FA has reported forest cover to increase between 1996/97 and 2002. This abnormal trend has been the focus of much discussion. The trend can be explained by a number of reasons. Throughout the nineties the Cambodian GIS/RS[26] unit was in its infancy and lacked expertise and experience. The techniques used during this early period were very basic with a high margin of error, relying mainly on visual manual interpretation. Since the 1996/97 assessments they have simplified the classification scheme considerably and moved towards more consistent digital processing techniques. While the 2002 map was made unsupervised by any independent body, for the 2005/06 forest cover assessment, quality assurance and data verification was pro-

[26] GIS/RS: Geographical Information Systems/Remote Sensing.

vided by GRAS A/S- Geography Department, University of Copenhagen, (FA 2008a), making this latest map most reliable of all.

The FAO (2005b) based their analysis on the FA's original data from 1992/93, 1996/1997 and 2002. They noted that the figures showed abnormal trends in categories such as "deciduous forest", "wood and shrub land" and "forest re-growth". FAO have found the 2002 data to be the most reliable, and have therefore adjusted the earlier FA figures accordingly. The earlier figures were calibrated in the following manner:

1. all forest categories were grouped together into one, and
2. the percentage of total "wood and shrub land" to total "forest" land in the 2002 (about 2.52%) was applied to respective figures in 1992/93 and 1996/97.

The result is a substantial increase of land classified as "forest" in 1992/93 and 1996/97 compared to the FA figures, seen in the above Figure X.1. Estimation of figures for 1990, 2000 and 2005 were then calculated using linear-inter and linear extrapolation.

Conversely, the Independent Forest Sector Review (IFSR 2004) have put more faith in the past figures and suggested that the FA 2002 analysis may have overestimated "deciduous" forest cover (the most abundant forest type) and underestimated "non-forest" by as much as 15%. Therefore, they have adjusted the original FA figures by decreasing "deciduous" forest and "non-forest" accordingly. While some shortcomings of the 2002 analysis are mentioned in the IFSR report, it does seem likely that they have made this simple assumption so that the general deforestation trend would continue in a linear fashion from the previous estimates made.

Based on the trends discussed above, conflicting estimates of historic national deforestation rates are made and displayed in Table X.1.

Table X.1 Estimates of net deforestation rates as percent of land cover and ha/yr by the Forestry Administration (FA), the Global Forest Resource Assessment (FAO), and the Independent Forest Sector Review (IFSR).

Time Period	FA		FAO		IFSR	
	Change ha/yr	% LC	Change ha/yr	% LC	Change ha/yr	% LC
1992/93 - 1997	55,372	0.31	88,478	0.49		
1996/97 - 2002	+ 77,150	+ 0.43	218,664	1.21	93,333	0.51
2002 - 2005/06	93,378	0.51	218,664	1.21		

Table X.1 shows that the deforestation rate differs substantially between the three sources. Even the deforestation rate reported by the FA for the period 2002-2005/06 that could be considered somewhat reliable, is significantly lower than the FAO estimate of 1.21 percent/yr. When a closer look is taken at the FA's recently published booklet of Cambodian forest cover (FA 2008a), the deforestation rate of 0.5 percent/yr becomes a little more suspect. This deforestation rate is calculated by dividing the total deforestation rate between 2002 and 2005/06 of 2.06 percent, by a factor of 4, i.e. the number of years between 2002 and 2006. However, out of the 15 LandSat image sections used to make the full picture of the country for the 2006 analysis, only 4 images are from early 2006, while the remaining 11 are from early 2005. The 2006 images account for less than one third of the whole country area. This means that the map is, for the most part, a

2005 map, and should therefore not be treated as purely 2006 map. Using 2005 instead of 2006 as the map year would have resulted in a deforestation rate of 0.69 percent/yr as opposed to 0.5 percent/yr. In reality the rate lies somewhere in between.

It should be emphasised that all the above figures report net deforestation rates as opposed to gross deforestation. For REDD projects only gross deforestation is considered relevant. With the data resources available to the study it has not been possible to estimate the gross deforestation, but there is no doubt that the gross deforestation rate would be considerably higher than the net deforestation.